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THE JOURNAL OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

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CITY OF DAYTON TO BE REVISITED

BACK in 1911, when the late Major Henry Souther was President of the Society of Automobile Engineers, the Summer Meeting was held at the Algonquin Hotel, Dayton, Ohio. At that time there were only about 900 S. A. E. members, and of those nearly 200 went to Dayton for the meeting. The members that went were given the opportunity of seeing the Wright brothers in what was then the new art of flying and in addition to visit many of the industries directly or indirectly connected with the automobile industry.

In the words of the Dayton mayor of the time, "Here in the heart of this Great Miami Valley—the greatest agricultural section of the Middle West, lies one of the most beautiful and most progressive cities in the entire country. Here is a city of a thousand factories whose busy hum provides employment for a happy and contented people; a city of homes, churches, and schools; a city of wealth, culture and intelligence; a city whose broad streets and avenues are filled with the evidence of the prosperity of our people."

Seven years to a day later the members of the new Society of Automotive Engineers are to revisit Dayton, not for the purpose of seeking entertainment, but to make a serious study of the problems now confronting every automotive engineer. With the Nation at war the Meetings Committee will do its utmost to make the two days, Monday and Tuesday, June 17 and 18, so filled with education and inspiration that every member of the Society who possibly can will find it essential to attend.

Business and Professional Sessions

A business session will be held during the meeting in order to receive reports of Society officers, committees and to consider any appropriate matters. A number of amendments to the Constitution were submitted at the last Annual Meeting (see page 5, January issue of THE JOURNAL) and in accordance with the Constitution of the Society these will be presented at the Semi-Annual Meeting for discussion and amendment.

Plans are now being made to secure a number of important technical papers and addresses for the Dayton Meeting. These will be selected with a view of their being of maximum service in helping the members to carry on war activities. With this same point in mind it is hoped to present to the members an extensive exhibition of military automotive apparatus. Dayton, the cradle of the art, offers facilities of all kinds for such exhibitions of aircraft operation, as formation flying, and demonstrations of shooting machine guns between propeller blades, also of propeller and wing construction.

It will be remembered that Wilbur Wright Field, for training U. S. A. aviators, is just outside of Dayton, also that the experimental flying field and factory of the U. S. Aviation Section is in the city and that the Dayton-Wright Airplane Company is in Dayton. The opportunity for service to the members of the Society who are doing aircraft work, but who may not have been able to see just how the results of their labors are applied, can be adequately realized from the above description of the aircraft interests in Dayton.

Exhibitions of several other types of automotive apparatus in operation will be arranged, providing the expected consent of the authorities is obtained. No member should miss this exceptional opportunity of witnessing the accumulated concrete results of the patriotic war service of the Society and of its membership.

Sessions at Triangle Park

All of the professional and technical sessions, the dinner, and the exhibition features will be held at Triangle Park, which is less than two miles from the heart of the city of Dayton. It is planned to hold a dinner for the members of the Society on Monday evening, June 17, and to have luncheon there on both Monday and Tuesday. Society headquarters will be established at the Miami Hotel, Dayton. A Bureau of Information will be conducted at the Miami and also at the Union Depot so that the members can easily secure any information regarding the accommodations, meeting arrangements, and exhibitions.

The registration of all members will take place at an office to be set up at Triangle Park. The distribution of badges and the sale of dinner tickets will take place at the same office. Reservations for the dinner tickets will be made at the New York office of the Society up to and including June 12, and after that date reservations will be handled in Dayton. It is quite possible, however, that the capacity of the Triangle Park hall will be reached before the 12th. Full information with blanks for reserving dinner tickets will be sent to the members in the near future.

Accommodations for Members

The bulk of the members attending the meeting will be taken care of at the Miami, Algonquin, Philip, Beckel

and Holden Hotels. In addition there will be accommodations available at the Country Club and at St. Mary's College, thus making a total of from 1000 to 1150 who can be cared for without billeting in private residences.

In case of overflow it is expected that arrangements will be made to secure accommodations at private residences, and also that hotel accommodations can be secured in Springfield, which is only a short distance from Dayton. All billeting, however, will be carried on from the Bureau of Information at the Miami Hotel, where representatives of a committee composed of Dayton members of the Society will be stationed.

In addition to the business and professional sessions of the Society, the program will be arranged to provide for meetings of the Council and of different Society committees. On June 16 the Standards Committee will meet to consider the work done during the six months' period between January and June. Preceding the meeting of the main committee will be meetings of a number of its divisions. The Sections Committee will hold a conference with the officers of all the different sections and will present for discussion the work the committee is now doing in standardizing procedure.

First Year of Navy Activities

A REVIEW of the United States naval establishment during the first year of America's participation in the war has been compiled and issued by the Committee on Public Information based on authorized statements by officials of the Navy Department. The extracts from this review given below have been selected with a view to their automotive interest.

Submarine Chasers

The Navy Department had prepared a design for a submarine chaser before the outbreak of the war. The ideal design for this purpose would obviously have been a vessel of armament, speed, seaworthiness, and cruising radius closely approaching the characteristics of a modern destroyer. As it was considered desirable to conserve the capacity for steel-hull construction to the building of destroyers and cargo vessels, a wood-hull construction was adopted for the submarine-chaser program, so as to take advantage of the yacht and boat-building industry.

It was found also that there was no possibility of obtaining steam power plants for these boats in the large numbers needed in the short space of time. An entirely satisfactory design of submarine chaser was prepared, having a length of 110 feet and driven by three 220-horsepower gasoline engines. Of these boats several hundred were contracted for during the middle of April, 1917, and practically all of these boats have been delivered. The contracts were distributed among 31 private concerns and six navy yards. The construction at many of the plants was completed in record time. The boats have given splendid service, and have proved even more seaworthy than was anticipated, although seaworthiness was the principal design consideration. Many of these boats have crossed the Atlantic Ocean in weather which has done considerable damage to accompanying larger ships. These boats have proved their undoubted superiority to any other type of boat built of wood for this purpose.

Naval Aviation

There has been marked progress in the development of naval aviation. Orders have been given for seaplanes, flying boats, dirigibles, and balloons. The above material is being built in private establishments and also at the naval aircraft factory in Philadelphia.. The first machine from this factory was completed March 1. Additional ones will follow in rapidly increasing numbers until about June 1, when it is expected to turn out at least one complete machine a day.

Seaplane Development

As the seaplane is an important means for attacking the submarine, special attention has been given to the development of aircraft devices. The past year has brought the perfection of the non-recoil gun, and the Lewis gun has been adapted to seaplane use.

Aircraft bombs designed to explode either on impact, if they hit a submarine, or at a predetermined depth, like the ordinary depth charge, have been developed and the required quantities are being made. Sights for their accurate aim and improved seaplane cameras have accompanied them.

Coastal naval aircraft stations have been established on both sides of the Atlantic. Approximately $400,000 has been expended on the home stations.

Naval Consulting Board

When the prospect of war became imminent the Naval Consulting Board held a special meeting in New York. Ideas were interchanged and all necessary confidential information held by the Navy was given so that means for combating the U-boat could be quickly and successfully met.

Problems were formulated and placed before specialists whose life study best fitted them to produce a successful solution.

Working in harmony with naval experts, the outcome of this meeting has produced excellent results.

Individual members of the Consulting Board have made close studies in developing ideas presented by the department and in perfecting devices of various kinds, among which may be mentioned submarine and torpedo detection devices and methods for decreasing the visibility of vessels at sea, protection of vessels against torpedo attack, protection of vessels against sinking when torpedoed, method of relining guns, experimental work on ordnance material and the development of the production of machinery, optical glass, aeronautical devices, and specialties and researches in chemical and physical problems.

In the work of examination of the great volume of inventions, ideas, and devices submitted, the Board has rendered a signal service. Letters, plans, and models were received at the rate of from five to seven hundred a day. In the past twelve months upward of 60,000 letters, many including detailed plans, some accompanied by models, have been examined and acted upon.

Worm Gear Bronzes

By W. M. Corse* (*Member of the Society*)

Buffalo Section Paper

Illustrated with Microphotographs and Charts

WORM GEARING is one of the oldest known mechanical movements. Its ability to give large reductions in speed in a simple and satisfactory way and in a compact mechanism has long been recognized. In the higher grades of worm gearing the worm is usually made of steel, specially treated to insure specific properties, and the worm wheel is made of bronze, also with specific composition and treatment. As this paper deals with the bronze element it will be of interest to learn something of the history of bronze, particularly as the oldest and best known worm-gear bronzes, the copper-tin, are the first kinds of bronzes about which we find any description in ancient literature.

In the excellent translation of De Re Metallica (published in 1556 by Georgius Agricola) which was made in 1912 by Herbert Clark Hoover, aided by his wife, some instructive notes are given on the history of bronze, from which I shall quote.

"It is possible to set up a description of the imaginary* beginning of the 'bronze age' prior to recorded civilization, starting with the savage who accidentally built a fire on top of some easily reducible ore, and discovered metal in the ashes; but as this method has been pursued times out of number to no particular purpose, we will confine ourselves to a summary of such facts as we can assemble.

"Founders' hoards of the bronze age are scattered over Western Europe, and indicate that smelting was done in shallow pits with charcoal. With the Egyptians we find occasional inscriptions showing small furnaces with forced draft, in early cases with a blowpipe, but later—about 1500 B.C.—with bellows also. The crucible was apparently used by the Egyptians in secondary melting, such remains at Mt. Sinai probably dating before 2000 B.C. Charcoal was the universal fuel for smelting down to the eighteenth century.

"Bronze articles have been found in the pre-historic† remains in Egypt as early as the IV Dynasty (from 3800 to 4700 B.C., according to the authority adopted). The question of the origin of this bronze, whether from ores containing copper and tin or by alloying the two metals, is one of wide difference of opinion.

"To our mind the vast majority of ancient bronzes‡ must have been made from copper and tin mined and smelted independently."

Chemical analyses of these ancient bronzes show them to contain from 2 to 10 per cent of tin, so that bronze suitable for use in worm gearing has been known for thousands of years. It was not until the nineteenth century, however, that much bronze was used for worm gear wheels. Wood was almost universally used prior to this time, but the advent of the automobile focused the attention of the mechanical world on the use of a better material.

One of the most common uses for worm gear reductions, until the advent of the automobile truck, was for elevators and similar hoisting devices.

*Manager Bronze Dept., The Titanium Alloy Manufacturing Company.
†Page 402, Note 42—Historical note on copper smelting.
‡Page 411, Note 52—Historical note on tin metallurgy.

Automobile rear-axle worm gears were not developed by the hoisting device manufacturers in the United States, however, but were largely imported from England. The high efficiency of this type of gearing as now made has led to its adoption in many industrial fields.

The main differences between worm gearing used for stationary power transmission and that used for automobile trucks are in the compactness and accuracy of machine work on the worm gear unit itself required with the latter.

In the less compact elevator mechanism the size of the gearing permits the use of lower grade material and less accurate workmanship. In the rear axle mechanism of the automobile truck, on the other hand, the space available and the mechanical efficiency demanded make it imperative that only high-grade materials and workmanship be employed.

Such a condition as has just been described lends itself profitably to scientific investigation.

The mechanical side of the problem has been described by H. Kerr Thomas in his book entitled "Worm Gearing." It has also been described before this Society by John Younger,* Cornelius T. Myers† and H. D. Church.‡

The metallurgical side of the problem has not been as thoroughly discussed and it is in hope of adding information to this part of the subject that the technical data in this paper are presented.

"Hour Glass" and Straight Type Worm Gears

When worm gear axles were first used in this country we found two types of worm gearing about equally regarded. These were the "hour glass" type and the straight type. The advocates of the "hour glass" type specified a bronze having a higher compressive resistance than those in favor of the straight type. As the "hour glass" type of gearing bears on a considerable surface of the worm and wheel while the straight type bears on a line tangent to the pitch diameter of the gear, it is obvious that in the former a greater total tooth pressure can be used without destroying the oil film than in the latter type. This is evidently why a bronze wheel having a high compressive strength is required in the "hour glass" type to withstand these increased pressures.

Phosphor Bronzes

The usual straight type of worm gearing requires a phosphor-bronze of about 88.7 parts of copper, 11 parts of tin and 0.3 parts of phosphorus. This alloy in chilled gears has the following physical properties:

Ultimate tensile strength, lb. per sq. in.	35,000-40,000
Yield point, lb. per sq. in.	22,000-25,000
Elongation in 2 in., per cent	6-10
Reduction of area, per cent	7-9
Specific gravity at 20 deg. cent	8.5
Brinell hardness number (500 kgm. load for 30 sec.)	75-85
Pattern maker's allowance for shrinkage, in. per ft	0.125

*Worm Drive Axles, S. A. E. Transactions, 1914, Vol. 9, Part 1, pp. 215-223.
†Manufacture of Worm Gearing by a New Process, S. A. E. Transactions, 1915, Vol. 10, Part 1, pp. 152-171.
‡Refinements in Truck Design, S. A. E. Transactions, 1916, Vol. 11, Part II, pp. 324-335.

Weight per cu. in., lb	0.31
Compression, elastic limit, lb. per sq. in	16.000
Coefficient of friction	0.0040
Modulus of elasticity	12,000,000 to 14,000,000
Resistance to impact, Fremont notched bar test (fractured section 7 by 10 mm.), kgm.-meters	2 to 4
Endurance of alternation impact, Landgraf-Turner or Arnold test, alternations	150 to 300
Resistance to shear by impact, McAdam machine, ft.-lb.	300 to 450

Copper-Tin-Zinc Alloys

A bronze for "hour glass" worm gears composed of about 85 parts of copper, 13 parts of tin and 2 parts of zinc, having a Brinell hardness number of about 100, has been used to some extent.

Chill-Cast Tin Bronze

The 11 per cent tin bronze was also used for the "hour glass" type when chill cast. In fact it was in this type that the chill cast bronze was first used.

The fact that the "hour-glass" type of gearing requires accurate alignment in three planes while the straight type requires accurate alignment in but two planes, has caused the latter to be adopted in automobile truck design. The "hour-glass" type is still largely used in electric passenger vehicles.

Copper-tin alloys to which phosphorus has been added are called phosphor-bronzes. When the percentage of copper is between 100 and 87 per cent the form of crystallization is the same. The temperature of the solidus of an alloy consisting of from 9 to 13 per cent of tin is about 200 deg. cent. lower than the temperature of the liquidus taken from the table of pyrometric data. See Fig. 1.*

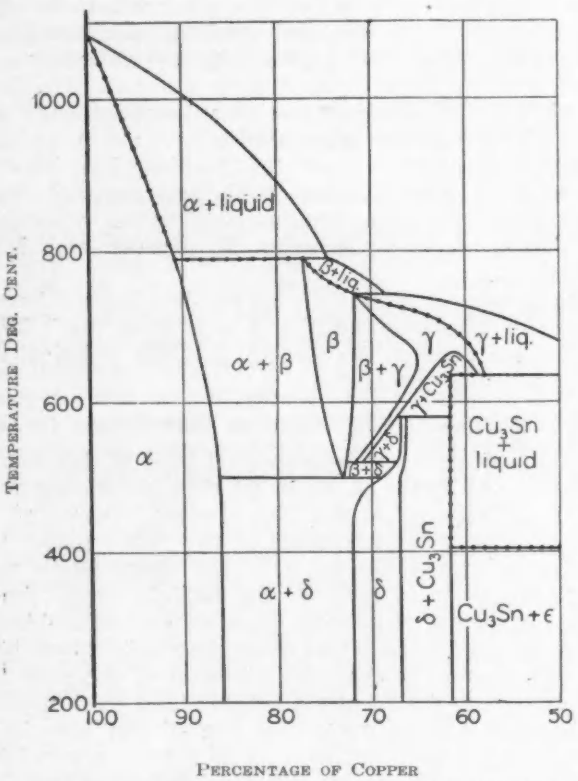

Fig. 1—Thermal Equilibrium or Cooling Diagram of Copper-Tin Alloys

*Fig. 1 is reproduced from "The Tensile Strength of Copper-Tin Alloys" by Shepherd and Upton, *Journal of Physical Chemistry*, January, 1905, p. 446.

Effect of Phosphorus

The addition of phosphorus up to 1 per cent apparently increases this difference in temperature. This condition is common to many alloys and means that during the cooling process a solid portion of the alloy is in contact with a liquid portion during a temperature drop represented by the difference between the temperatures of the solidus and the liquidus. This temperature difference is constant for a given composition, when the rate of cooling is normal.

Alloy Cooling Diagram

For the information of those unfamiliar with cooling curve diagrams, I would state that the solidus is the line bounding those regions within which alloys are completely solid, and the liquidus is the line bounding those regions of the diagram representing entirely fluid alloys.

In the diagram, Fig. 1, the line bounding the area α is the solidus of completely solid alloys of copper and tin. The curve bounding the area marked "α plus liquid" in Fig. 1 is the liquidus of entirely fluid copper-tin alloys.

Tin Sweating or Liquation

In foundry practice the result of this difference in temperature causes a phenomenon known as liquation. It is commonly called tin sweating because, when the casting is poured in a sand mold numerous drops of a silvery metal ooze from the risers and top during the process of solidification. This silvery metal is not pure tin, but rather a copper-tin alloy containing about 22 per cent of tin and having a Brinell hardness number of about 240.

Examination of the bronze with a microscope reveals a structure like Fig. 2 in which the lake-like areas are the silvery colored material, known as eutectoid, which is distributed throughout the mass. As the weight of metal poured into the average automobile-truck gear mold is between 75 and 100 lb., the solidification process is relatively slow, thus allowing ample time for the formation of the eutectoid. The casting, therefore, contains large areas of this relatively hard material, which makes it more difficult to machine uniformly. This produces an uneven surface on the tooth of the gear with the attendant mechanical disadvantages of such a condition.

Chill Casting Produces Finer Grain

The most practical method for overcoming this unevenness of structure is to chill the liquid metal in the casting by mechanical means. Such chilling produces a finer grain in the metal throughout practically the entire cross section of the gear rim and reduces the amount of eutectoid, or hard material, thus giving a more uniform alloy. This is clearly shown in Fig. 3.

The chilled phosphor bronze worm wheel has been proved to have many advantages over the ordinary sand cast article. Thousands of such gears in service have shown better wear and therefore longer life.

One of the essential properties of a gear bronze is the ability to burnish or cold-work its own surface. A high-grade bronze will increase in surface hardness from 30 to 50 numbers on the Brinell scale when burnished by machining or service operations.

Manganese Bronze

Manganese bronze possesses high strength but does not burnish well; it therefore does not make a satisfactory gear metal.

Aluminum Bronzes

The need for a strong gear bronze, however, in order to effect economies in the use of a relatively expensive material, has been recognized. This has led to the investigation of the aluminum bronze series of alloys; these are known to possess high strength, remarkable resistance to alternating stresses caused by shock and vibration, and resistance to abrasion and wear.

The composition with the best properties for gears is about 90 parts of copper and 10 parts of aluminum. Small percentages of iron added to the above formula give increased strength in tension and compression. The burnishing properties were found to be satisfactory, fully equalling or surpassing those of the phosphor bronzes.

Advantages of Aluminum Bronze for Worm Gears

The phenomenon of liquation present in the phosphor bronzes is found to be practically absent in the aluminum bronzes. This is shown in Fig. 8.*

From the foundryman's standpoint the absence of liquation in these alloys means that if advisable the chilling process can be omitted and a bronze casting be produced that shows no hard spots with their attendant difficulties. Where it is desirable to partly cast the teeth in the gear the aluminum bronzes, because of the absence of the hard spots in the sand cast material, offer greater possibilities than the phosphor-bronzes.

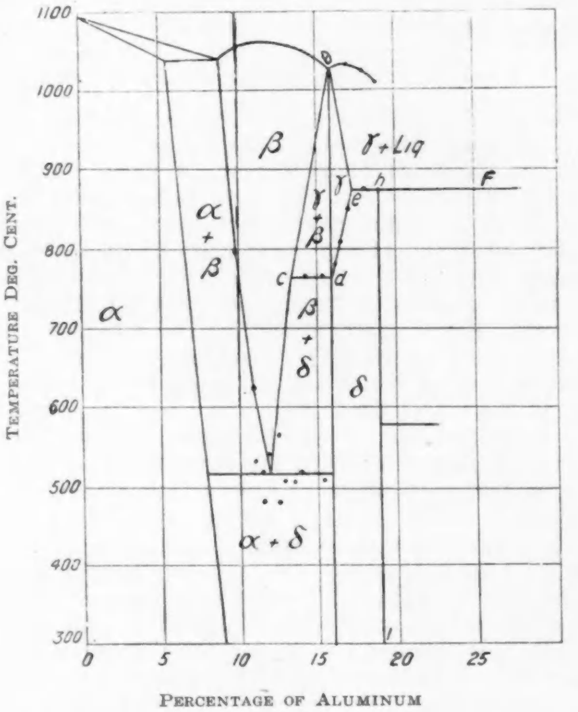

Fig. 8—Thermal Equilibrium or Cooling Diagram of Copper-Aluminum Alloys

Note small size of triangular area at upper left-hand corner of this diagram, as compared with large "alpha plus liquid" area in Fig. 1

In addition, the 10 per cent aluminum bronzes can be heat-treated, giving a metal with 25 per cent increase in tensile strength, 100 per cent in yield point and 50 per cent increase in hardness without any increase in the cost of machining.

In certain designs these improved properties may be found very beneficial. Figs. 4 and 6 show the structure of aluminum bronze under the microscope. Fig. 7 shows the structure of quenched aluminum bronze and Fig. 5 that of the heat-treated alloy.

The 10 per cent aluminum bronze containing 1 per cent of iron has the following physical properties:

Ultimate tensile strength, lb. per sq. in	65,000-80,000
Yield point, lb. per sq. in	23,000-28,000
Elongation in 2 in., per cent	20-30
Reduction of area, per cent	21-29
Specific gravity at 20 deg. cent	7.5
Brinell hardness number (500 kgm. load for 30 sec.)	92-100
Pattern maker's allowance for shrinkage, in. per ft	0.22
Weight per cu. in., lb	0.27
Compression, elastic limit, lb. per sq. in	19,000
Coefficient of friction	0.0025
Modulus of elasticity	15,000,000-18,000,000
Resistance to impact, Fremont notched bar test (fractured section 7 by 10 mm.), kgm. meters	7 to 10
Endurance of alternating impact, Landgraf-Turner or Arnold test, alternations	3500 to 5500
Resistance to shear by impact, McAdam machine, ft.-lb.	750 to 850

Addition of Iron to Aluminum Bronze

A 10 per cent aluminum bronze containing 4 per cent iron, first described* by Mr. Comstock and the author in 1916, shows results superior to the above and bids fair to supersede it.

Economy of Material Effected with Aluminum Bronze

Recent tests of worm gear axles by the U. S. Army on the Mexican border demonstrated the need of a gear bronze with a high resistance to shock. A comparison of the results obtained by the Fremont and Landgraf-Turner tests shows the great superiority of the aluminum bronzes in this respect. With the greater strength and toughness of aluminum bronze as compared with phosphor bronze, and its decreased weight per cubic inch, the designer can effect economies that total from 30 to 50 per cent in material.

The manufacturing difficulties formerly present with aluminum bronze have been overcome so that worm gear wheel castings of this material are now being made in quantities with as low a percentage of rejections by the purchaser as with phosphor bronze.

In the new field of tractor designing aluminum bronze should be given careful consideration on account of the economies possible to effect through its use in worm gear castings and other heavy-duty bronze parts.

I do not wish to be understood as recommending one class of alloys over the other for all gear castings. Undoubtedly the mechanical phases of the problem have a direct bearing on the selection of the proper gear bronze for the job.

The hardness of the steel worm, its machine finish and the accuracy of finish on the worm wheel teeth have a direct bearing on the proper selection. These conditions are best determined by the designing engineer. It is my desire to give the metallurgical facts in each instance and leave the final selection to the engineer because of his experience with the finished worm gear mechanism.

I do wish to point out, however, that the bronze is fully as important as the other parts of the mechanism and should be as carefully made and controlled.

*Fig. 8 is reproduced from "Some Experiments upon Copper-Aluminum Alloys," by J. H. Andrew, *Journal of the Institute of Metals*, March, 1915.

*"Some Copper-Aluminum-Iron Alloys," Corse and Comstock. *Trans. Amer. Inst. of Metals*, Vol. X, pp. 119-132.

With the idea of adding to the information on the subject, I have attempted to present here such metallurgical data as would seem to be pertinent.

I wish to acknowledge my indebtedness to Hugh R. Corse for many valuable suggestions relating to the subject matter of the paper and to Geo. F. Comstock for his aid in preparing the microphotographs and the tables contained herein.

Explanation of Illustrations

Fig. 2—Bronze containing 11 per cent tin, cast in sand, etched with ammonia and hydrogen peroxide, followed by ferric chloride, showing light patches and streaks of eutectoid between the darkened alpha dentrites.

Fig. 3—Same alloy as shown in Fig. 2, with same etching but chill cast, showing only traces of eutectoid and much finer dentritic structure.

Fig. 4—Typical structure of sand-cast aluminum bronze containing 10 per cent aluminum, etched with ferric chloride and hydrochloric acid.

Fig. 5—Same alloy as Fig. 7, with same etching, but after further heating to about 600 deg. cent., followed by slow cooling, showing a very fine grain similar to that found in tempered steel.

Fig. 6—Same alloy and etching as Fig. 4, but with a twenty-fold greater magnification, showing duplex structure of the dark constituent.

Fig. 7—Structure of 10 per cent aluminum bronze, hardened by quenching in water from 900 deg. cent. and etched with ferric chloride and hydrochloric acid, showing acicular structure like martensite in steel.

INTERCHANGEABILITY AND ACCURACY OF FITS

THE British Engineering Standardization Committee is doing fine work in its successful endeavors to standardize much of our national mechanical effort in setting limits to the amount of inaccuracy which mechanical engineers shall generally agree to admit in those of their productions which are to be produced in quantities of which the design calls for very close fits.

Let us take one example of particular interest to the commercial-vehicle builder and repairer. The Standardization Committee has recently set limits, with considerable accuracy, to the overall diameters which shall in future be permissible for road-wheel rims to which solid tires and their steel bands are to be fitted. On the face of it, it is a very desirable effort. But it would appear from the vehicle users' point of view that any limits on road wheels, be they steel or wooden ones, are in their fineness likely to prove relatively ineffective if the wheels so treated are subjected to rough handling, as in very many cases they must be. For the accuracy of the rim of a wheel to be calculated in thousandths of an inch is worse than useless and a waste of time, after very little distortion due to rough handling or even to ordinary normal use on the roads has occurred.

Limit to Limit Setting

It is not suggested that accuracy of workmanship is undesirable, but that there is a distinct limit to the utility of limit setting in its relation to standardization. The user is, above all, concerned with the facility with which any replacement he may have to undertake can be made without skilled fitting and persuasion. The high degree of accuracy secured by transmission chain makers in their production is, of course, necessary for chains which are to run on new sprockets, but some at least of such accuracy is relatively unnecessary when the sprockets are almost worn out, as they frequently are when replacements are undertaken, however useful they may be to facilitate production. The user in such a case finds no difficulty in fitting, but he is in no sense appreciative of the accuracy of the product which is sent to him as a replacement.

Commercial Vehicle Fits

The plea is made for a rather wider outlook in design, that designers may not become obsessed by the necessity for minimum tolerances or, in plain English, for the closest of close fits. It is rather suggested that the best design for commercial-vehicle purposes is that which enables parts or, at any rate, units to be assembled in position with the smallest possible intimate relationship to the other parts in conjunction with which they have to work. High regard is felt for the designer who can produce certain parts of his machine which are perfectly effective, but of which the fits need be no better than that of the top of the kitchen stove, and there are not a few such instances to which similar cuteness could be applied in connection with the commercial vehicle. Design of that sort, implying a very intimate insight into the uses to which the parts will be put when they are in service, is of the highest rank.

Interchangeability does not necessarily depend upon accuracy of fit. It may in many cases even more depend upon the initial provision for definite inaccuracy—shall we say, for intolerance or for very generous limits? Many minds have already turned towards the problem of after-war models. The excessive tests to which chassis have been put for war service in all parts of the world will not be without their serious lessons to manufacturers and to designers alike; they should also not be without benefit to the user. While strict limitations have necessarily to be imposed upon the grinder, upon the machine tool setter and similar specialists for productive purposes, it rests very considerably with the designer to insure that the finished chassis shall need as few close fits on it as may be consistent with fast production and effective running, but particularly with ease of maintenance by a relatively unskilled hand. Workshop tolerances are necessary, of course, from the point of view of eliminating subsequent manual modification, but the design should be, so far as possible, of such a nature as to permit reasonably wide limits. There is a good deal to be said for intolerant design of the kitchen-stove order!

From an article entitled "The Limit," published on page 534 of the Feb. 7 issue of *The Commercial Motor*, London.

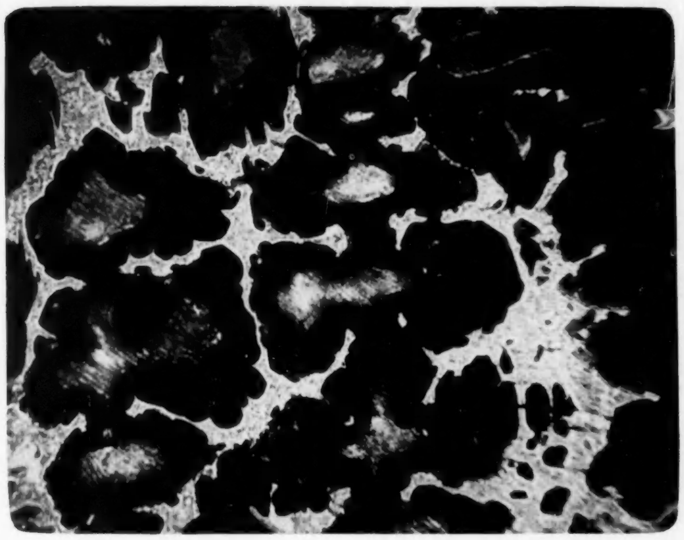

FIG. 2—COPPER-TIN ALLOY CAST IN SAND
Magnification—200 Diameters

FIG 3—SAME ALLOY AS IN FIG. 2, BUT CHILL CAST
Magnification—200 Diameters

FIG. 4—ALUMINUM-BRONZE ALLOY CAST IN SAND
Magnification—20 Diameters

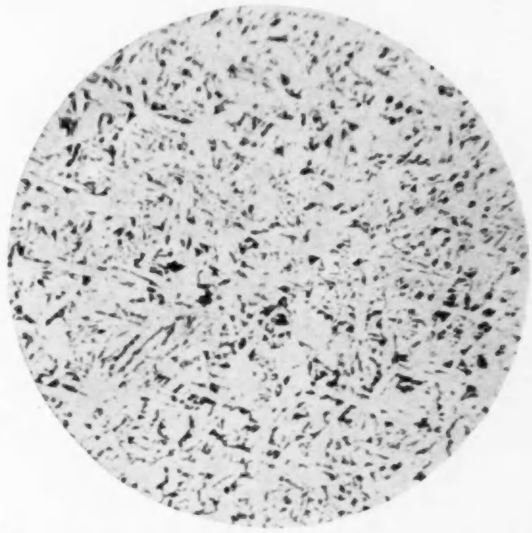

FIG. 5—SAME ALLOY AS IN FIG. 7, BUT REHEATED AND COOLED SLOWLY
Magnification—200 Diameters

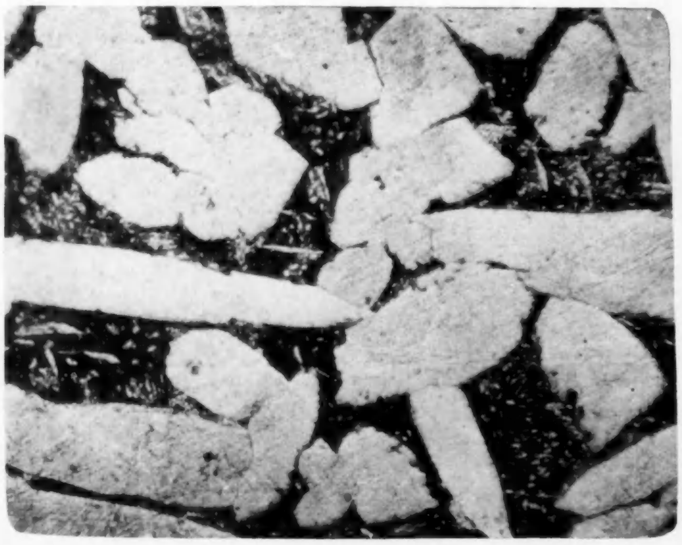

FIG. 6—SAME ALLOY AS IN FIG. 4
Magnification—400 Diameters

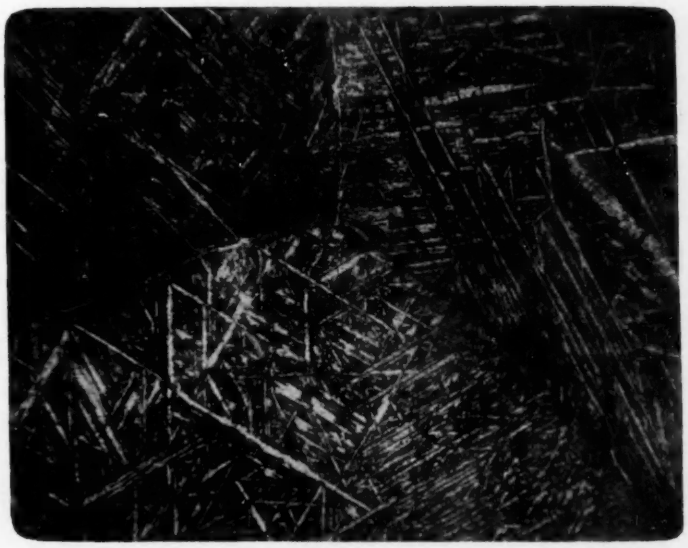

FIG. 7—ALUMINUM-BRONZE HARDENED BY QUENCHING IN WATER
Magnification—200 Diameters

Automobile Body Design and Construction

By E. W. Goodwin* (*Non-member*)

Detroit Section Paper *Illustrated with* Photographs and Chart

THE automobile body today is, from a selling point of view, the most important part of the automobile. The general automobile-buying public are not as ignorant today as they were several years ago. The wise manufacturer is not turning his car over to the public to try out, as in former years, and the public having learned this, take it for granted that when they buy a car, the chassis is mechanically correct and the engine as nearly perfect as the price they pay for it will permit. They are seeking the best-looking car as a whole, body lines, comfort and pleasing color schemes being the basis upon which they purchase. Therefore, it is up to the body designer and to the salesman to sell the car. No matter how good the chassis may be and no matter how good the selling force may be, if the body design is poor the car is bound to be a failure.

Unfortunately, the majority of manufacturers have not awakened to the necessity for a body engineer and designer. They assign the body designing to the chief engineer or chief draftsman and the body is, therefore, produced in the engineering department by inexperienced ability in this line.

One of the most noticeable features in this year's automobile shows in New York was the tendency of manufacturers to copy. This, in our estimation, is a very poor practice, even though it has been the practice since the automobile started to exist, and was also the practice in the old carriage days. It is poor policy for a manufacturer to insist upon his body designer copying another's design, if the designer has the ability to originate.

When I was a little boy, being artistically inclined, I was copying or reproducing an etching. My father came in to see what I was doing and he gave me the following advice: He said, "My boy, never copy anything—be original, but if anybody copies you consider that you have done something worth while." In my work I have endeavored to follow my dad's advice, but must confess that at times it has been necessary to stray from the straight and narrow path laid out by him.

Influence of the Chassis Design

A great difficulty facing the automobile body designer and a drawback which the manufacturer very unfortunately does not always take into consideration pertains to the chassis design. The manufacturer or his engineer will design a chassis invariably without first considering what body is going to be put on.

They go further than this, frequently insisting upon the body designer designing a speedster, roadster, four-passenger, seven-passenger, town car, sedan and limousine all on a single style of chassis, with one pitch to the steering post, no alterations in the gearshift levers, pedals, or anything else. This is an improper way to start in to manufacture a chassis.

The lay-out of the chassis should be left to the designing engineer and the body engineer, who should cooperate to produce a chassis suitable to the requirements of the trade. The steering post should be so designed that it can be easily adjusted in the final assembly. It is a great advantage in a production car to have even the pedals adjustable.

One of the greatest difficulties encountered is to produce a body which will please both Mr. Short and Mr. Long. It is equally difficult to construct a seat cushion so that Mr. Fat will be comfortable as well as Mr. Lean. Such problems as these must be settled by men experienced in designing, building and trimming automobile bodies.

Adjustable pedals are of great advantage in laying out a production body, for they give the designer a leeway of say three inches in leg room which is quite sufficient to take care of Mr. Short and Mr. Long.

The adjustable steering post is very essential when the manufacturer wants to mount on one chassis not only a speedster body, but a full line, including limousine and town car. We all know that the speedster needs a very low, rakish steering post and the limousine needs a high post.

Seating Arrangements

After we have decided upon the necessary position for the driver and his companion, and found them entirely comfortable in all designs of bodies, our thoughts are then shifted to the passengers in the tonneau. Many designers and manufacturers lose sight of the comfort of their customers, particularly where the auxiliary seat is concerned. Their main object is to fold this seat out of the way, regardless of whether anyone can sit in it when in carrying position, and much less do they take into consideration the comfort of the passenger riding in the auxiliary seat. While the auxiliary seat is placed in a car solely to take care of emergency cases, it should be so built as to be suitable to ride on, or it might as well be omitted entirely. An auxiliary seat should be of such size that the average person can sit on it without undue discomforts, and there should be knee room so that one can sit facing forward without inconvenience. There should also be space enough for the feet and the cushion and back should be so constructed that the average person can ride on it with a certain degree of comfort. Some of the higher-priced cars go so far as to use a spring in the auxiliary seat, but this I do not consider necessary, owing to the fact that the auxiliary seat is used only for short distances.

The above argument in regard to comfort may be extended to the rear seat in many cars. Many different view-points must be taken into consideration in designing the rear seat of an automobile. The present-day design and construction of the society lady's corset must be considered. It is so designed that it is impossible for her to sit in comfort below a certain level, and this level unfortunately makes it necessary to have not only the

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touring body, but the closed car as well, of a height that is inconsistent with a long, graceful body design.

After this necessary height has been determined in our closed jobs, we must take into consideration the head-room. This must be such that the feathers on our lady's hat will be cleared. The back of the car must be far enough away so that her broad-rimmed hat will not interfere. To accomplish this and also a striking design is a hard problem. The old standard dimensions for limousine have to be shaded considerably nowadays to obtain an attractive car that will be comfortable.

Height of Eye-Line

Another point in body design which is seldom taken into consideration, but which for some time back the author has endeavored to employ, is the correct height for the persons sitting in a car. The eye height is one of the most important details in body design. If the passenger's eye, when riding in a car, is above the height of his eye when walking or standing erect, an unnecessary nerve strain occurs. To ride above the standard eye height creates a strain which will tire out the average person on a long drive. This does not occur if the passenger sits below this eye line, for he is then closer to the ground and feels more secure and the nerve strain is not nearly as severe as it is when riding at a normal height. Nerve specialists, I think, will all agree with me in regard to this particular detail. There are, unfortunately, many cars in which the designers have not taken this detail into consideration.

Sedan a Popular Type

The head of the sales department and the body engineer should be close to each other in regard to body design. The salesman, as a rule, knows what bodies his customers demand. The requirements of body types change from season to season, but the present automobile buying public seem to be leaning toward a sedan. This type of body is strictly an automobile body design. By a sedan we mean a body in which all the passengers are inclosed in one compartment. This particular type of body can have one, two, three or four doors as the choice may be. The fewer doors the better for the manufacturer and the builder. It costs less to build and there are fewer possibilities of rattles and other noises which develop in the doors. The body can be made much lighter and stronger, taking into consideration its weight.

This type of body is becoming very popular owing to the fact that so many competent chauffeurs have been drafted. The sedan body was originally designed as a family car, and the high cost of living has also had much to do with its increasing use, especially with people of medium circumstances. Anyone owning a sedan body as a rule does not care for the society of a chauffeur. The owner himself, his wife, or one of his children drives the car. If the car is properly equipped it can be locked up when left alone without as much danger of its being stolen as an open car.

This type of car can be constructed so lightly that it is very little heavier than a seven-passenger car, and the comforts derived from it, both in summer and winter, cannot be compared with those of any other open car on the market. I think we will find that there will be more sedan bodies sold within the next two or three years than any other type.

The demand for these bodies at the New York Show seemed to be greater than in previous years. There was one body at the Astor Salon which appealed to me very strongly. It was a very light sedan built by a leading New York body builder for his personal use. The design of this body was very poor in that the owner never intended anyone to get in or out of it in comfort, but that is a secondary consideration. It was the construction of this body which appealed to me as well as the possibilities obtainable by exerting a little thought and the use of up-to-date ideas in body design.

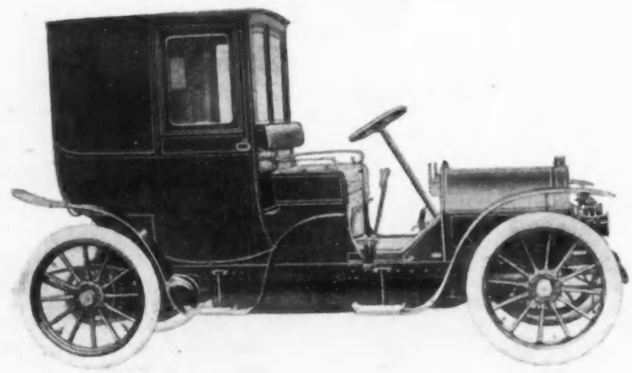
This body was constructed of wood with the exception of the cowl. The interior, including the arm rests in the rear seat, were all finished in natural wood. The top construction was of light carlines, close together on a very light frame, finished in natural wood without head lining. The door frames were finished in natural wood and covered with openwork cane, similar to a chair bottom on the inside. The upholstery was all removable so that it could be taken out and the body washed with sponge and water. The back above the belt line, including the roof, was covered with straw-colored khaki. The design of this body was not very attractive, but the general idea was good, and with the increasing high cost of materials, labor and living, I predict that this body when properly designed and laid out is going to be a very popular one among the automobile buying public.

One of the most interesting features at both of the Shows was the tendency of almost every manufacturer to copy the Packard design in one way or another. Aside from this, there was very little new material.

A great many manufacturers exhibited bodies which they had shown last year, particularly at the Astor show, this being due to the fact that the Astor Salon originally was an importers show and all the importers that exhibited this year showed old models which were imported before or shortly after the outbreak of the war.

Body Construction

The question of construction has been more in evidence in the last two years than at any time since the automobile became popular. This question has been "Of what and how are we to construct our automobile bodies? Shall they be of wood, steel, or a combination wood frame with steel, aluminum or composition panels?" Some old Eastern builders advocate an all-wood body. Others state that an all-steel body is the proper construction, while the great majority are using wooden frames with metal panels.



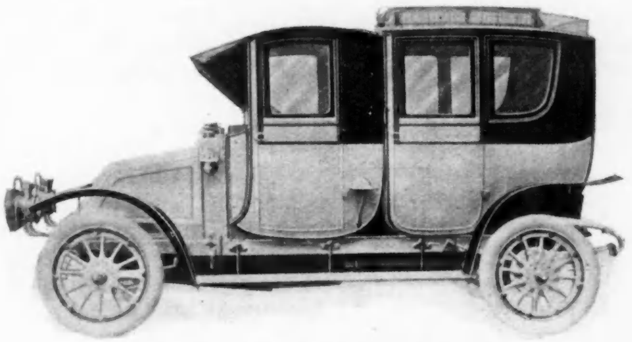
Broughams Have Small Closed Bodies and Open Front Compartments

Color Schemes

The tendency with the manufacturer is to get his chassis as short as possible, and it is, therefore, necessary

to paint the body to help out these conditions and to make the job look as long and as low as we can.

This can be very readily done by a selection of colors and particularly by blacking off moldings and striping. With a short high-sided body it is absolutely necessary to eliminate all the vertical lines possible in painting the body and adopt all the horizontal lines possible, without overdoing it. The horizontal belt molding with body panels painted a different shade than the chassis will assist wonderfully in carrying out this long low appearance, but the minute vertical lines are put in such as blacking off door moldings in the body panels or putting



Double Coupe or Berlin with Separate Compartments for Driver and Passengers

stripes on the louvers in the hood, immediately the body appears to be shortened and its height increased.

Color combinations and shades should be very carefully taken into consideration by the sales department in selecting the color schemes. A good job can be ruined easily by poor color combinations. It is well to keep colors as near the same as possible to avoid any possibility of clash in shades. If a blue is favored, the wheels should be of one shade of blue and the body panels of another shade, while striping should be carried through in a light or dark shade of the same color. The same color schemes should be followed out through all the different colors—maroon, red, yellow, etc. Endeavoring to combine yellows with greens, greens with blues, yellows with blues, or any such combinations immediately sets up a clash.

Almost any color can be used in combination with a black or white. Black and white can be used together with a very pleasing effect, but these are the only two colors which can be combined with any other color with any degree of harmony.

Trimming and Upholstering

Simplicity in trimming is equally as important as simplicity in body design and harmony in colors.

It has taken a long time to educate the automobile-buying public, and every year the upholstery and trimming of the open and closed bodies have gradually become simpler. It was only a short time ago that a limousine was not up to date unless it was trimmed with broad and narrow lace until it looked like a crazy quilt, but today it is impossible to find a job where any great amount of this material is used. In most high-class jobs it is absolutely eliminated. Where window lifters are employed they are usually made out of the same material as the upholstery or head lining.

One of the most attractive features in the finish of the closed cars is the individual hardware. This individual design in interior hardware sets off a car remarkably well and gives it a tone of individuality which to my mind is a necessity in a high-grade, high-class product.

Those using individual hardware at the shows this year were: Chalmers, Franklin, Pierce-Arrow, Peerless and Marmon. There were a few others that had spatterings of individual design, but it was not carried out as completely as in the above-mentioned cars.

Classification of Automobile Bodies

Since the automobile came among us, particularly in the last few years, manufacturers have been misusing the body classification. A good example of this is where one or two manufacturers are calling an inside-driven coupe or cabriolet a victoria. Others have adopted the name brougham for the sedan.

Last year the S. A. E. attempted to standardize the names of the different types of automobile bodies, so that everyone interested in automobiles would know what the salesmen were talking about. This has been absolutely ignored in a great many cases, with the result that when a salesman is talking about a brougham, the purchaser does not know just what he means until he sees a photograph or the car itself.

Many of these body names have been handed down from the old carriage days and from the early manufacture of automobile bodies in Paris and England, and with all due respect should be followed as nearly as possible.

There are a number of new names which have cropped up since automobiles came into vogue. One of these is known as the town car. General Healy was asked a year or so ago to explain his version of this particular type of body. He said that there was no such body as a town car body and the one to which this name was applied was no more than a coupe. The name town car applied to a body is really as new as the name sedan; as far as design is concerned it should always be known as a coupe body.

The name town car is thoroughly American, but just where it was first used I do not know. It is used with reference to a small closed body seating two, three, four or five passengers in a permanently closed compartment, the driver's compartment being open with no roof extending over the driver. This type of body is known as the town car limousine or town car landaulet, as the case may be.

Early Sedan Bodies

The sedan type of body was a long time getting its name. The first body of this type was designed and built by the author in New York and was dubbed a sporting limousine, but afterward was called a social limousine, also a society limousine.

The word sedan was used in connection with the body about 1909 or 1910 when a body was designed and built for a New York society lady who desired a body built as nearly like a sedan chair as possible. This body was referred to in the automobile magazine articles as a sedan chair body. It was not until some time after this that some of the manufacturers adopted the name sedan to apply to the sporting, social or society limousine.

Types of Broughams

The brougham body, which was named after Lord Brougham of England, was a small closed body with a dicky seat, with no extension roof over the driver, the front compartment being open. A pure English design of this body always was built with a square corner. There was no quarter light back of the door light and a very small rear light. The word town car, however, was never used in connection with this particular design of body.

There were three different types of broughams. The

extension brougham had a small extension forward of the coupe pillar into which was built a full-width folding seat, the passengers facing the rear.

The three-quarter brougham was like the extension brougham only in that the extension forward of the coupe pillar was much larger and had a permanent full-width seat, the passengers facing the rear. The front of this seat extended fairly well into the door opening. This particular design of body was usually built for two people. In some cases the rear seat was built wide enough for three, and I have known cases where a small drop seat was placed in the division, but this was not common practice. This type of body was very popular with people not caring to be seen, such as widows in mourning and people of distinction who always attracted attention when in public. This is one of the exclusive body types which has been mistreated in this country. In the last six or eight years, almost every type of body possible has been called a brougham, which is absolutely wrong.

Berline a French Name

The word berline was first used in connection with the limousine and was called a limousine berline. This was a limousine in which the entire upper part of the body was inclosed in glass. This name was afterward applied to an entirely closed body with four doors, the driver's compartment separate from the passengers' compartment. The old French name for this type of body was known as a double inside-drive limousine, or double inside-drive landaulet. Where the rear compartment was small, being arranged for two or three people, it was termed a double inside-drive coupe. Some people are under the impression that the word berline is a German name, but I cannot find that it was ever used in connection with a German body; it is purely a French name, being pronounced berline, not Berlin.

Difference in Limousines

The limousine is a permanently inclosed car with four doors, the driver's compartment being open, with a permanent roof extending over the driver's seat.

The demi-limousine was a term given to a touring car with a solid back and permanent roof, with a small quarter light back of the rear doors. This was also called a demi-limousine-cab, according to the shape of the rear quarter. This, a number of years ago, was a very popular body, and the author believes that it will not be long before it will again become popular, as it is a commonsense type.

The cab-side limousine is like the limousine, excepting that it has side windows back of the front door to protect the driver, the driver's compartment being otherwise open.

The limousine three-quarter was similar to the limousine, with the exception of a small window and extension forward of the rear door, in which was placed a folding full-width seat, upon which the passengers rode backward.

The dorsay limousine was similar in type to the limousine, with the exception that it was always designed with a square corner, and the lower line of the body formed one continuous line from the bottom of the coupe pillar back under the body and up the back, ending at the roof line.

These types of limousines are all old French designs, but when America entered the automobile field they had to have something new, so designed what was known as the sporting limousine. This was a permanently inclosed car with one, two, three or four doors, with the driver and passengers in one compartment. The original design of this body had individual front seats with passage between or a folding seat and a bucket seat. This was afterward dubbed a social limousine and later a society limousine. This body was designed to take care of the young wealthy American who preferred to drive his own car.

The word sedan I have mentioned before was afterward applied to this body and has stuck to it to the present.

Coupe or Small Limousine

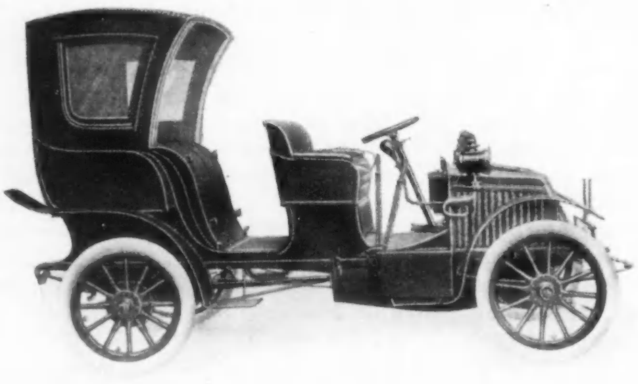
The coupe body was a small limousine to seat two, three, or four people in one compartment, with four doors, the driver's compartment being open without any extension roof over him. This is the body that the Americans renamed and dubbed a town car, and it has held this name.

The word coupe was also used in connection with the limousine. This was frequently called a small limousine or a town limousine. When so used it referred to a body with the rear compartment inclosed to seat two, three or four people, the driver's compartment being open, with a full extension roof over the driver.

The inside-drive coupe was simply this small limousine body moved forward until the driver was able to sit on the rear seat and drive the car.

Cab Bodies Not Used

The cab body has practically gone out of existence. This was a body with the driver sitting on a small box seat without any back. The rear part of the body had



SHOWING THE CAB, AN OBSOLESCENT TYPE

an entrance between the driver's seat and the rear compartment. This rear compartment was built exactly like the old horse cab, with doors that were hinged on the sides and a glass front which hinged at the top and swung up to the roof. After the two passengers entered the rear compartment, the two doors were swung over and the window was let down, inclosing them entirely.

Six Different Landaulets

There were about six different types of landaulets: The landaulet, three-quarter landaulet, landaulet limousine, phæton landaulet, double landaulet and inside-drive landaulet. All these forms of landaulets were bodies with leather backs which allowed the back of the body to be open.

The phæton landaulet was more of a touring car, the entire roof being collapsible. This type of phæton landaulet was frequently called a collapsible landaulet.

The double landaulet was like the double limousine or berline, and was frequently termed landaulet berline, or berline landaulet. These were made in a number of dif-

ferent ways, some of them having only the rear part of the body let down, others made with the entire top collapsible, leaving the entire body open.

Touring Cars and Phætons

We are all well acquainted with what is known as the touring car, runabout and roadster. The touring body was originally known as a phæton. The word touring car was an afterthought. A great many builders and manufacturers still cling to the word phæton, which is a good old French name and is always properly used

THREE-QUARTER LANDAULET BODY TYPE

when referring to a small low closely built body of touring type.

Victoria an Open Body

The victoria body is one of the "swellest" bodies built. This was frequently called a milord body. This type of body was built for two passengers sitting on the rear seat. This rear seat was swan-shaped. There were no doors whatsoever to this body. The driver and footman sat on a box seat with no back, a small victoria top covered only the rear seat, and it was equipped with six fenders, over the front wheels, the rear wheels, and a short fender which ran from the front part of the driver's seat down to the rear step. This was a body which was very popular for driving in the parks, boulevards and avenues. It was always very finely upholstered, the top of real leather, lined with broadcloth and all fittings usually of silver. The milord body was exactly like a victoria, with the exception that there was a running board in the place of the four steps and the extra little splash fender. This is another type of body which has received many knife wounds from the American manufacturers who have been casting around names and have disgraced the victoria body by applying it to almost any type of closed body with which they happened to feel like using it. The victoria body was never a closed body. It was entirely open, and whoever dreamed of using it in connection with a closed body was indeed a dreamer.

Other New Terms

The words coupelet, cabriolet, are new names which have cropped up since the automobile came among us. The name coupelet is frequently applied to an inside-drive coupe, while the word cabriolet is applied to an inside-drive landaulet or a landaulet with a leather roof and back.

A year or two ago somebody thought it a great idea to build a sedan type of body with the center pillars removable. It has not been discovered who originated this, but from a builder's point of view he had better keep it secret, because we are all looking for him. This type of body is known as a convertible. This body has had a very favorable place in the automobile world, but I venture to say that no man who ever bought one ever had the removable pillars out more than once, and we all hope that another season will see the last of the convertible bodies, but we must recognize them as long as they are in demand.

THE DISCUSSION

H. A. ROSE:—Is there any standard dimension which will allow the driver to get in and out of the front seat easily and still give the right appearance to the car? There is only one car that I know of on the market which really lets a man get in and out easily, and it is a pretty cheap one. There are even very expensive cars that one cannot get in and out of comfortably.

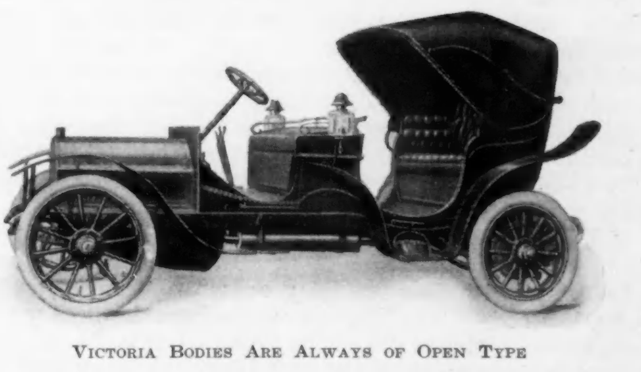
MR. GOODWIN:—The policy I have followed ever since I have been in the business is to build a body so that I could get in and out myself. As I considered that I was about average I measured my own body and built a set of little jointed wooden manikins. Later, these were made of celluloid. When the chassis engineer comes in and says, "Here is your chassis, now build something around it," I usually lay out my chassis to scale and put the manikin in and build the body around it.

BODY DIMENSIONS

However, I have always tried to stick to certain dimensions. The average man measures about 18 in. from the center of his hip to the center of his knee, and from the center of his knee to the ball of his foot, about 18 in.; so I usually take a straight line right over the top of the cushion. I have settled on 38 in. as the standard for my work.

Now there are some operators who cannot reach that far, but they can if the pedal has an adjustment of about 3 inches.

Another dimension that I always try to follow, in laying out a four-door body, allows foot-room to get into the front seat. For the driver to get in and out with comfort that should never be less than 10 in. Usually I try to maintain the same distance between the door pillar



VICTORIA BODIES ARE ALWAYS OF OPEN TYPE

and steering wheel, but it is almost impossible. If there is a space of 6 in. there, however, one can still get around the wheel comfortably.

The distance from the wheel to the back cushion can vary. It all depends on the driver whether he is going to be comfortable; but for a production car it should be about 14 inches.

Many cars are designed so that it is almost impossible to get by the steering wheel with a heavy overcoat on.

That clearance should never be less than 7 in., and it can be as much as 10 in. and still be comfortable.

The distance from the floor to the top of the cushion does not make any difference.

The average man, sitting against a hard back, measures out to the front of his knee about 25 in., so the auxiliary seat should have 25 in. clearance from the division. There is only one auxiliary seat made that I know of which permits advantage to be taken of the side pocket. Attention should be given to this point.

The height of the auxiliary seat, from the bottom of the well where the feet rest, may be from 14 to 16 inches.

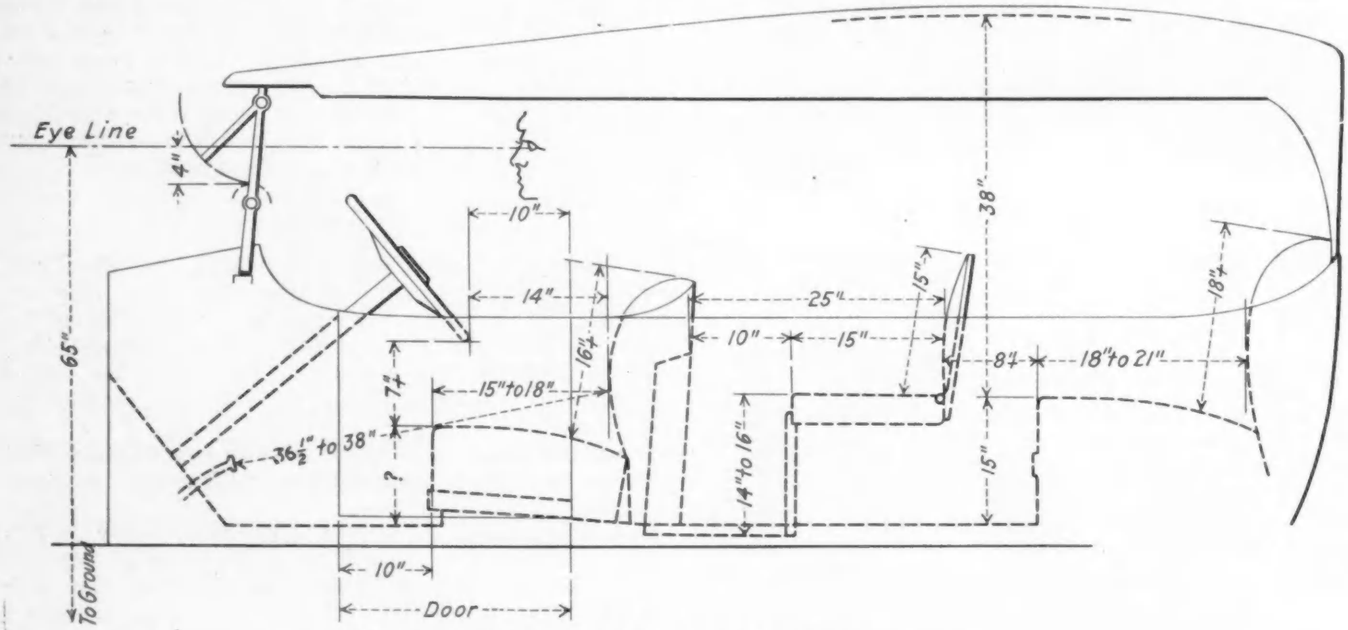
The width of the seat should never be less than 15 in.; if it is, the passenger will hang over the seat, which is uncomfortable. Its depth should not be less than 16 inches.

The back-seat dimensions vary quite a little. The at 38 in. The 38-in. dimension is taken in a straight line over the top edge of the cushion.

We invariably figure that the average person will take up about 15 in. width of seat, but in the rear seat that would mean a rear cushion of about 45, 46 or 47 in. That is about what the average person calls a three-passenger rear seat. We used to call 51, 52 or 54 in. a seven-passenger job.

I think the six-passenger is the coming body. It is very rarely that we see seven people in a touring car; usually there are four, sometimes five, and sometimes that fifth person sits on the auxiliary seat. So to get this body design low and snappy I think a two-passenger rear seat, with a pair of auxiliary seats, is going to be a very popular body.

I think we ought to adhere strictly to the body nomenclature. If we want to get an individual name, we should



Suggested Dimensions of a Seven-Passenger Body

most comfortable height for a rear seat is 15 in.; the depth varies. It is a hard job to build a production body and have all the ladies satisfied, because they vary more in stature, I think, than men. I usually make the depth of the back seat 19 in., and sometimes 20 in., depending on the construction of the back of the seat. If there is a lot of room, and a soft cushion, I drop that down sometimes to 18 in., but where there is a shallow back and a hard spring, I make it as high as 21 in.

I like to have the back-seat height in both the touring car and the limousine 20 in. This makes a comfortable seat, which does not interfere with anything, and a long, low body. The height must be kept down as much as possible. The back may be even as low as 16 in., but that is not comfortable as it catches the passenger in the shoulders. I like to have it 18 in., or even 20 in., if there is room.

A good deal of consideration must be given to the front seat, because usually there is a cut-out for the auxiliary seat in a seven-passenger, and in the phaeton body a cut-out for toe room, if we want a short, snappy job. The front seat is not as flexible as the back seat, so we must adhere closely to the dimensions given.

In a limousine with a very high-pitched steering post and the seat high above the floor, this is always figured use it in combination with the correct nomenclature. Otherwise we will not know what we are talking about.

Roof Height

C. C. Hinkley:—What is the rule for roof height with respect to the seat cushion and the top height with reference to the eye line?

Mr. Goodwin:—The height from the top of the cushion to the head line, in either limousine, town car or any car for production work, should never be less than 38 in. I try to stick to 39 because I find that I keep out of trouble in that way. The head-room from the floor up can vary, but that 38 to 39 in. from the top of the front part of the cushion to the head lining should not vary.

There are many types of bodies in New York that cannot be sold on account of lack of head-room. I measured one that was only 33 in. from the front cushion, but it was a very deep front cushion, and the occupant in dropping into the seat went down to the seat frames. When settled there would be just about the head clearance obtained with a good substantial cushion with 38 in. from the front of it to the head lining. The eye line of the person sitting in the car is 65 in. from the ground.

Heating Arrangements

T. J. LITLE:—The present closed car is not sufficiently heated. The man in the trolley car is very often more comfortable than the millionaire in his automobile. There is not a car heater on the market that will heat a car adequately; they will heat a small car, but not a large one.

A great deal of energy is going to waste which we should utilize in the heating of cars in the winter time. About a third of all the energy we buy at the filling station goes to waste; it would not be a difficult matter, I believe, to design an efficient heater to make people who ride in enclosed cars comfortable.

During a cold spell last winter, I tested in my own car one of the heaters which was intended to heat a closed car. After a 10-mile run, going at 20 m.p.h. with the heater in use, we raised the temperature of the car exactly one degree. In other words, we ran 10 miles and had a certain temperature. We cooled the car off and turned on the heater and obtained one degree increase in temperature. Now that kind of a heater would be all right as a foot warmer, but not as a car heater. I think heating is a very important point with a closed car.

MR. MOORE:—I am not interested in automobile bodies from the designing point of view, but I happen to be the owner of one of these sedan so-called "squeakables." I would like to ask how it was originally intended that the driver should get into the front seat? When I go between the front seats I have to slide through edgeways as I cannot get in crossways. I find it very difficult to get in if I have on an overcoat.

Clearance Between Front Seats

MR. GOODWIN:—The distance between seats should not be less than 8 in. I have seen a number of designs where that is reduced to 6 in.

A. A. HARWITH:—Some English manufacturers arrange body designs nicely and at the same time meet the customer's comfort requirements. They make the steering column adjustable, so that the same steering column is well adapted for a low speedster, limousine or touring car. After the body is designed and put in place, the column is raised enough to have a comfortable seat, and to allow the driver to slide in easily behind the steering column. To make the body look low and sporty, some manufacturers bend the frame right behind the steering wheel. Some of the American manufacturers use the same design.

What is called a cabriolet, a French and English design, not known in this country at all, reminds me of the latest type of convertible sedan, with the difference that the whole top is made of genuine leather. It folds like a victoria or sedan touring top; but it is heavy and makes a regular sedan when it is up. It was first designed in Paris in 1914, and I have seen it on English jobs about 1913 or 1914. It is a seven-seat job, with glass partitions behind the driver's seat. The partitions drop into the walls and doors, and the top unhooks and folds back. It looks a little larger than the regular touring car and makes a fine body.

MR. HINKLEY:—After one of these cabriolet tops is used in a folded position, is it not practically ruined for use as a top?

MR. HARWITH:—No, for special irons are used on the sides similar to the 1914 touring top of the Pierce-Arrow.

D. MCCALL WHITE:—Napier used the cabriolet type of body in England in 1910, but I do not believe that it would be at all suitable in this country. It would simply go to pieces as the leather top cracks. Referring to the general design of the chassis for the body, I think that the wheelbase is going to be lengthened and the chassis scientifically designed so that the car will still remain as light as before, but proper room will be obtained in the body. The Crossley Company turned out a little four-cylinder job about 80 by 120, afterwards 80 by 131 mm. The wheelbase was lengthened to 130 in. to obtain sufficient room, although it was still a light job. The European tendency is for four-passenger and six-passenger jobs and I believe we will come to that in this country.

Distance to Pedal

Mr. Goodwin's distance from the pedal to the back of the front seat is about one inch too long in my opinion. About 37 in. is a good average. There are cases where we make them even 36½ in. Whether the foot must be kept on the clutch-pedal all the time depends on the type of car.

MR. HINKLEY:—Mr. Goodwin lengthened that an inch last year. His old standard was 37 in.

MR. WHITE:—In England in the old types of cars using engines that did not have uniformity of torque at low speeds it was necessary to use the clutch frequently and to keep the heel on the floor board and the toe on the pedal. This meant that the distance from the floor board to the top of the pedal was not more than 3 in. This practice is found in the latest European cars. The use of a transmission brake is the only way to accomplish this because brakes on the rear wheel require the big movement common to most American cars. If the pedals are raised another 3 in. the job does not look well. I consider it unsightly for the pedals to protrude too far from the floor board. I put the adjustable steering wheel into the Napier cars during 1910 and 1911. The steering box was on a trunnion which came through the side bar, with a nut on the outside to tighten it. An adjustment on the cowl or instrument board took the torque reaction of the steering column. By slackening both nuts we could get just the steering position desired. The same applied to the change-speed mechanism, which, of course, is difficult with the present central control, but formerly we could make a fine adjustment on the change-speed mechanism and brake lever, so that we could have practically one standard steering column, change-speed lever, and brake lever for all kinds of chassis.

Now that good roads are coming we have the question of lower chassis. Today most American car builders attempt to get low cars by cutting down the body sides, which is absolutely wrong. The proper way is to lower the side bars and keep the body high so that it will at least come almost up to the shoulders; then the passenger is really sitting in the car instead of being half out of it. I do not think this will be accomplished until the road clearance can be reduced.

In 1911 or 1912 I brought out a chassis with as low as 6½-in. road clearance. We could bring the side bars down to 19 in. from the ground, but it was necessary to use a worm-drive rear axle, with the worm underneath so that the transmission could be down low. Otherwise the floor board would be too high.

Road Clearance

MR. HINKLEY:—Would the road conditions today warrant decreasing the road clearance?

MR. WHITE:—No, I do not think that the road clearance can be much less than about 9¾ in.

MR. HINKLEY:—Would it be a mistake for us to at-

tempt to make a car lower, by sacrificing some other features?

MR. WHITE:—Yes, I think it would be.

MR. HINKLEY:—Would it be better to have a longer wheelbase?

MR. WHITE:—Yes, I think it will be a few years before it is possible to get the side bars as low as is the practice in Europe.

MR. HINKLEY:—It has always been my experience in trying to make a universal steering gear, in order to get the low, rakish appearance, that the leg room lengthened out faster than the angularity of the wheel decreased.

MR. WHITE:—With the limousine the steering gear can be thrown quite a bit further forward from the back of the seat, and with the sporting car the steering wheel can be brought into the driver's lap, if the steering wheel is a tilting one.

We tried several models of heaters Mr. Litle refers to, and one of the first troubles we encountered was the noise of the exhaust, which could be heard inside of the closed body. That was improved and the next was the smell of the paint from the heater.

The question of temperatures was then improved. Mr. Litle says he got only about one degree of heat, but the reason was that the Cadillac eight exhaust is very cool. It has been suggested that water might be used to bring up the temperature of the closed car.

GEO. E. GODDARD:—I do not believe that the dimension given in the side elevation tells the whole story. The body width at this point must be taken into account, particularly considering the general tendency in design, which makes the body rather narrow at this point.

I believe a diagonal dimension, taken from the nearest point on the wheel to the pillar, of about 8 in., is about as little as is permissible. In closed bodies in which the pillar continues to the roof rail it is obvious that this 8 in. is insufficient. Should not the dimension given, between the steering wheel and the seat back, of 14 in., be considered the minimum?

MR. GOODWIN:—No, not the minimum.

MR. GODDARD:—In limousine practice, where the chauffeur is expected to sit up straight, 15 in. will work out satisfactorily, but in building a car to suit the average buyer, and where no adjustable wheel is used, I believe that 14 in. is small, and also that it should not be over 16 in. Of course, it depends not only on the length but also on the angular position of the steering wheel.

MR. GOODWIN:—As an average, I find that 14 in. is just about as far away as one can get, that is, on a straight line from the front of the upholstery. It can be reduced to 11 in. I have driven racing cars with 11 in. The average man is not so thick through his chest, but 16 in., when considering the distance the driver would sink into the upholstery, would necessitate a pretty long reach. I doubt that there are many cars which, if measured, would be more than 14 or 15 in. at the outside.

MR. GODDARD:—The 25-in. dimension from the back of the seat to the auxiliary seat back makes no allowance for a robe rail. Should that not be considered the minimum dimension?

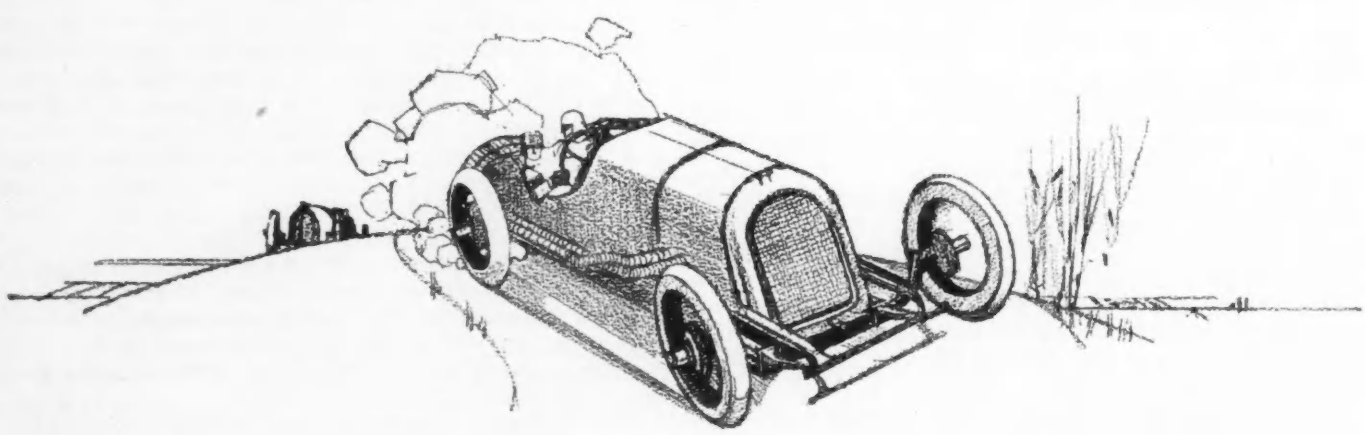
MR. GOODWIN:—That is the knee clearance. The knee does not usually come in contact with the robe, for when sitting in the auxiliary seat it is practically necessary to take down the robes, otherwise they would hang down into the auxiliary seat opening.

MR. GODDARD:—Is not the head-room of 38 in. measured at the front edge of the cushion? I find that the practice varies considerably in the taking of this dimension.

MR. GOODWIN:—Everybody varies the body dimensions. That is why there are so many uncomfortable cars.

MR. GODDARD:—I have made it a practice to measure the head-room from a point 12 in. back from the front of the cushion, this being the part where the passenger actually sits.

MR. GOODWIN:—Yes, they really sit there, but if we go back as far as that, we have got to allow more than 13 in.; the cushion naturally slopes back, which gives more head-room. The front of the cushion remains more stationary than the back. Some cushions slope more than others, and softer springs and other conditions must be taken into consideration.



Recent Trends in Automobile Design

By J. Edward Schipper* (*Member of the Society*)

Detroit Section Paper *Illustrated with* Charts

WAR demands a speeding up of movement. The methods of the lax times of peace do not suffice for the quick results demanded in war time. Under the demands for the movement of unprecedented quantities of materials and manufactured products, not to mention the greatly increased passenger traffic of a military and commercial nature, the facilities of the nation's railroads and travel arteries have been strained to the breaking point. With the railroads of the country taxed to their utmost limit, automotive transportation must come to the rescue.

A century ago ideas of distance were gaged by the abilities of the horse. Although over one hundred million acres of land are cultivated annually in this country to support the horse, nevertheless, the days of thinking in terms of horse transportation are done. Quick, certain and, above all, efficient transportation is the greatest demand of the age. Let us see how the automotive industry fits in.

Change From Peace to War

We have been awakened from our gilded dream to find out that our Chinese wall of self-sufficiency has crumbled, largely because transportation has advanced to such an extent that countries, which in the days of "no entangling alliances" were remote, have become our neighbors. This great change has been accompanied by a revulsion of feeling in this country which would have been considered impossible.

Our great national fault has been extravagance. The great forests which once covered the country with timber have been cut away so that today lumber is cheaper in the oldest countries of the world than it is here. Our minerals, the game from the fields and forests, all the gifts that nature bestowed on this country have been used with an unsparing hand and naturally along with this the habits of our people have been molded until we have become known as the most wasteful nation in the world. It is but natural that this molding of our nature should express itself in the tools we use. It is shown quite clearly in our automobiles. The American people have been buying cars by size and weight. Two cars, each costing the same, but one larger and more gaudy than the other, if placed side by side and offered for sale would not compete, as the larger one would command nearly all the attention in spite of the fact that the other might be a better piece of engineering from end to end. But a change has come. A great wave of economy has swept over the country.

Recent Changes in Public Attitude

We have suddenly awakened to the fact that the automobile of today is inefficient and uneconomical, and, at the same time, the people have been awakened by the exigencies of war to the fact that their daily habits *must* be more efficient and economical.

The result is natural. People now want the most for their money. When they buy transportation they want the most transportation for the money expended at the time of purchase as well as afterward in maintenance and operation.

The meaning of *efficiency* is clear to any engineer. It is simply output in terms of input. If a machine is 80 per cent efficient, its output is 80 per cent of its input, whether measured in terms of heat, distance, dollars or any other of our standards of measurement. When we say automobiles of today are inefficient, and are not returning to the owners proper values in transportation for the money expended, we simply mean that what the owner gets back in transportation is not enough in proportion to what he puts in.

Take, for instance, the man who owns a car weighing $2\frac{1}{2}$ tons who drives downtown to his office, a distance of 5 miles, and in the evening returns, another 5 miles. If a friend were to offer to take him to his office and back for a dollar a day he would probably laugh at him. Yet, in all probability, this is what it is costing him. The upkeep of such a car, even without including the high depreciation of a car of this weight, will easily amount to 10 cents a mile.

The car weighs too much for the passenger load. The man weighs probably 150 lb. The car weighs 5000 lb., that is 33 lb. for every pound of passenger weight. It is true that the car is heavier than the average, but this example is taken merely to illustrate the point. With five passengers in the car the weight would be over 6 lb. per passenger, and even this is too much.

Considered from the transportation efficiency standpoint, there are two sides to the ledger, one showing what we put in and the other what we take out. We put in money in terms of fuel, time, weight of vehicle, labor (if a driver is employed) road or track maintenance and vehicle maintenance. We take out just two things, passenger-miles and comfort. Comfort costs extra on an automobile as it does on a Pullman car. In a commercial vehicle we take out ton-miles alone.

Cost Factors of Operation

Most of the cost factors are in the control of the engineer; indeed, most of them are simply weight factors. Considered one by one, they are:

Fuel Consumption.—Primarily affected by weight and to a moderate extent in average practice by design.

Time.—Controlled by law and traffic conditions.

Weight of Vehicle.—The crucial factor involving displacement and weight of power plant, length of wheelbase, physical qualities of materials, vehicle characteristics and purposes.

Road or Track Maintenance.—Covered by state tax and in many states a function of weight and horsepower.

Vehicle Maintenance.—Factor of weight, materials, design, handling, road conditions and a number of other variables.

*Technical Editor, *Automotive Industries.*

In the past all of these items have been high and we must make rapid changes to reduce them if we wish to fit in with the desires of the public.

No Real War-Time Cars

The new cars at the shows are hardly war-time cars. They have been under test out on the road for so long that they antedate the economy wave which has swept over the country. They serve to show only that the tendency was in the direction of this new demand. In a great many ways this demand is not even known to the people themselves. The attitude of the people at the shows was to a large extent noticeable. They were searching for something they did not find and so they took the nearest thing to it, or nothing.

These people were looking for a car in which the weight per passenger was at the lowest limit. In other words, a car that utilized every inch of wheelbase to the greatest possible efficiency, that was not of a displacement higher than necessary to carry the load, that had materials which returned the greatest amount of service because of their light weight and scientific disposition.

No longer were they looking for the biggest car that they could buy for a certain sum of money. The American public has had a psychological shock from which it has not recovered. It behooves the automobile industry to design to suit this new state of mind.

At this time of the year when all the new cars have made their appearance and the designs for the following season have all been disclosed we are naturally interested in noting the trends of development. This year, for the reasons pointed out, the trends cannot possibly teach us as much as in the past because the designs in which they are included cannot possibly have taken into consideration the national psychological change. Nevertheless, since we were beginning to move in the right direction it is important to study these developments to see what should be accelerated in order to meet the new conditions and new standards of conservation and economy.

At the shows there were but five new chassis incorporating new power plants and redesigned to a sufficient extent to classify them as being absolutely new. During the year two additional chassis which can be classified as really new were also brought out. This gives a total of seven entirely new chassis which were not on the market a year ago. All of these have new power plants and are the latest types under normal development. It is interesting to note that of the seven, five are four-cylinder and five have overhead valves.

Probably one of the results of more carefully shaped combustion chambers, combined with a tendency toward larger valves, more scientific cam contours, better designed intake ports and galleries, and superior carburetion owing to the hot-spot manifold and carbureter mixing chambers giving better velocities, is that mean effective pressures have been increased.

Shorter Wheelbase Probable

If automobile factories carry out designs suggested by the changed attitude of automobile buyers, the changes to be made during this season will be more radical than anything in the last decade. There has been no incentive for the engineering department to make every inch of wheelbase return an inch of body space or other concrete qualities, as riding comfort. As a matter of fact we have had more than enough wheelbase. At the present cost of materials and with the present objection of the public to carrying around any more useless car weight than is absolutely necessary, manufacturers are not going to be as wasteful of car length.

What can be done in this respect is hardly appreciated. For example, one concern which brought out an entirely new car this year shortened the wheelbase 7 in., and, after rearranging the layout, had as much room in the tonneau as in the previous model, and 2 in. more in the front compartment. This was not done with the idea of cutting wheelbase length to the limit, but rather was more or less accidental to a redesign. In addition to more passenger space and a smaller engine, a gain of 50 per cent in economy of fuel, a large gain in weight, and a better performing car were secured. This better performance is in acceleration, low-speed torque, and speed range on high gear.

In an analysis of this kind it is only fair to remember that it has been impossible to realize many of the anticipations of a year ago owing to the fact that the minds of engineers who would ordinarily be on development work, have been employed on the vast task of designing and making ready for government production necessities. Scarcity of materials has likewise retarded development this year. Without doubt, aluminum would have been employed to a greater extent than ever before, but the fact that it remains scarce and expensive has prevented its use on any but high-priced products.

Average Engine Design

If we were to take all the American passenger cars on the market and combine them into a general average, the cylinder size would be $3\frac{1}{2}$ by 5 in., and the average

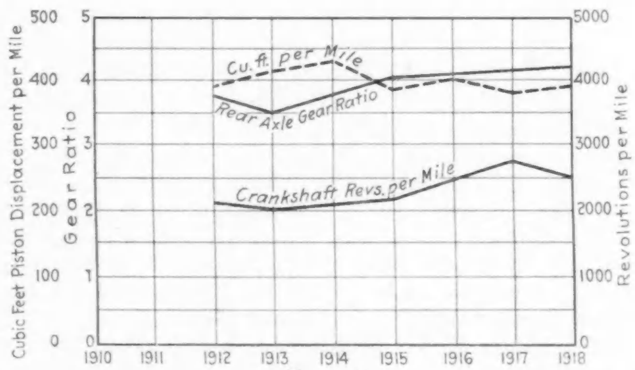


Fig. 1—Yearly Trends of American Passenger Car Design in Piston Displacement and Crankshaft R.P.M. per Mile and Gear Ratios

displacement, based on the relative percentages of numbers of cylinders, would be 269 cu. in. From the standpoint of engines of different numbers of cylinders the following averages obtain:

Number of Cylinders	Bore, In.	Stroke, In.	Piston Displacement, Cu. In.
4	3.6	4.95	221
6	3.46	5.00	282
8	3.13	4.59	282
12	2.87	4.96	386

Contrary to what has been outlined as the probable future in the development of passenger-car engines, the average engine is larger to-day than it was a year ago. The piston displacement is now 269 cu. in., as compared with 222 formerly. The gear ratio has been altered from

4.15 to 4.22, yet the increase in average tire size from 31 to 34 in. has prevented a large increase in the displacement per mile on high gear. A year ago this averaged 384 cu. ft. It is now 388 cu. ft. Thus, although actual

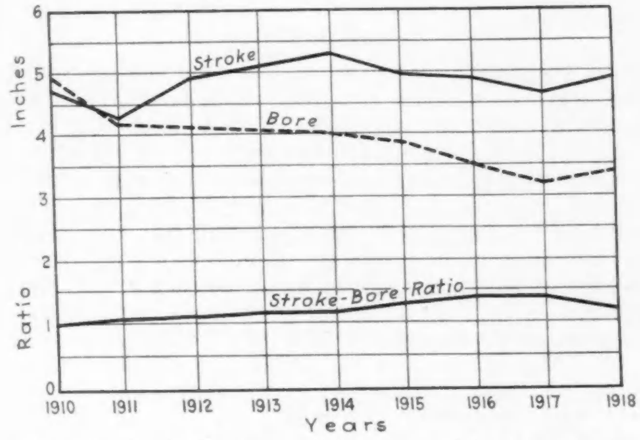


FIG. 2—AVERAGE CYLINDER SIZES DURING THE PAST EIGHT YEARS

engine displacement has increased, car ability, as measured by displacement per unit of distance, has not increased.

Overhead Valves Increase

A census taken before the shows indicated an increase in overhead valve construction of 2.2 per cent with the corresponding reduction in L-head engines. The additions to the list as brought out by new cars at New York and Chicago bring the increase in overhead valve engines to about 3 per cent. This percentage is rather lower than it ought to be because the assembled cars practically all use L-head engines, due to the fact that the largest builders of stock power plants confine their efforts to the L-head type. As each selection of an engine represents

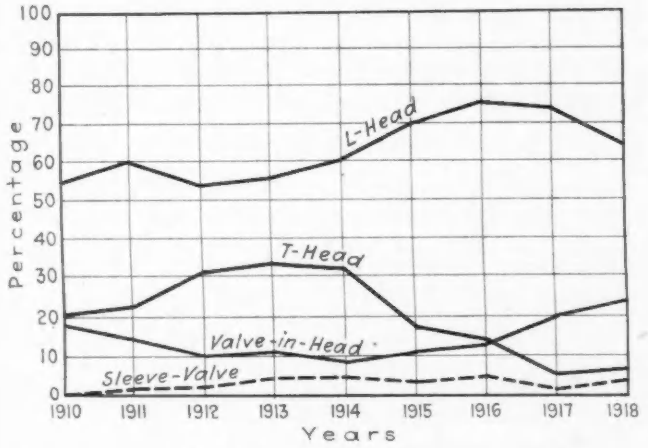


FIG. 3—THE TREND OF VALVE CONSTRUCTION ON AMERICAN PASSENGER CARS

what might be called an engineering ballot in favor of that type, it is fair enough to take the chassis and obtain the average as given.

The conclusion must be reached that an unqualified indorsement has been placed by the industry upon the overhead engine. The fundamental reason behind this development is naturally the effort to secure the greatest possible output from any given displacement. High volumetric efficiency, with lowest possible losses through wall cooling, naturally would tend to favor constructions where it is possible to use the most direct entrance into the combustion chamber and at the same time secure the most advantageous combustion chamber shape.

All the new engines brought out during the year have detachable cylinder heads; makers who have not employed this feature before have adopted it on their products. Two Detroit makers, one manufacturing a high-grade twelve, and the other a high-grade eight, have changed over to the detachable head, showing that its practicability is recognized for the V-type engine as well as for the vertical. Early difficulties have been solved, and they have been found to be due mainly to two causes: either insufficient metal around the studs or poor distribution of water space around the head.

Fuel Question and Design

For three years the fuel question has exerted a highly important influence on engine design. This year there has been a crop of the so-called hot-spot manifolds. There is no doubt that the use of these has resulted in a material reduction in the warming-up period. This is of considerable importance, as with the highly efficient choking devices employed on up-to-date carbureters a stream of raw gasoline is drawn into the cylinder during the

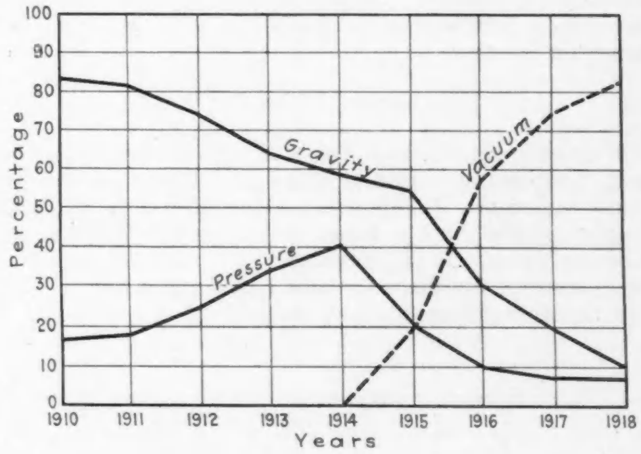


FIG. 4—CURVES SHOWING THE TREND IN APPLICATION OF GRAVITY, PRESSURE AND VACUUM GASOLINE FEED SYSTEMS

cranking period, and naturally some of this leaks past the piston rings, with the result that considerable crankcase dilution occurs, destroying the lubricating qualities of the oil.

Cold-Weather Starting

Cold-weather starting is engaging the attention of automotive engineers. During the year many suggested means have been offered for solving the difficulty. Probably the most promising of these is the method by which a small electric coil is employed to heat a small quantity of gasoline, which is thus evaporated, throwing into the cylinder a drier product which facilitates combustion and at the same time is more free from the evils of crankcase dilution. In one of these primers the electric coil is in the float bowl of the carbureter, and in another a cylindrical well is employed of slightly larger diameter than the pencil-shaped coil.

Single ignition has been continued, and has been improved in detail. The battery, breaker mechanisms, and coil have all been improved. One company has developed a battery in which rubber separators are used with threaded wicks, which carry the active material in the desired manner. Breaker boxes and coils operate faster than ever, this being necessary to take care of the in-

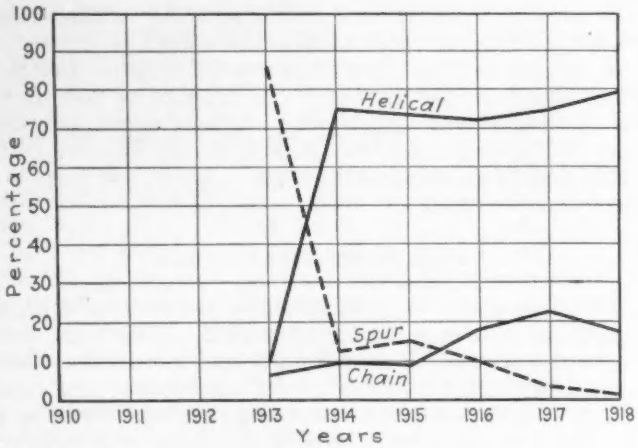


Fig. 5—Trends in the Driving Gears of Automobile Accessories

creased crankshaft speeds at which engines operate. Manufacturers have difficulty in keeping up the quality of breaker points, owing to the scarcity of platinum and tungsten.

Engine Balancing

Engine balancing has been studied more carefully than ever, and counterweighted four-cylinder engines are now more numerous. Inherent balancing, in which the rotary balance of the shaft is taken care of in the design is also meeting favor. It is interesting to note that the use of pressure feed for the main bearings is increasing. While the percentage does not show up very high, owing to

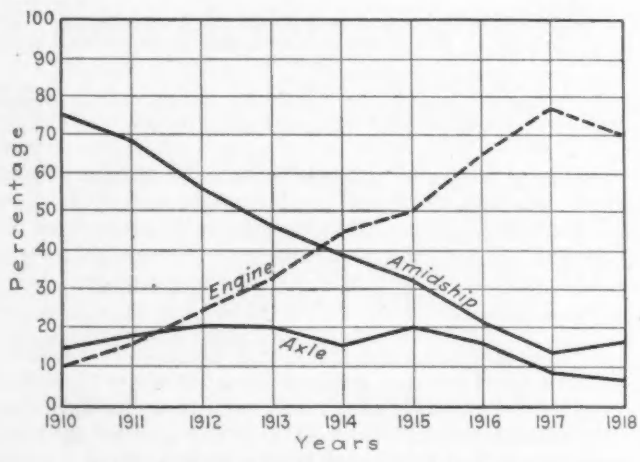


Fig. 6—Trends in Transmission Location

the fact that there have been some new models added, which neutralize the figure, the proportion of engines with drilled crankshafts is increasing. In practically all cars selling at prices which permit drilling the shaft this method is being used.

It will be noted that the average wheelbase has increased by 7 in. It is safe to assume that this will not be the case another year. The fundamental reasons noted at the beginning of this paper preclude the possibility of again adding weight unless there is a very good reason for doing so.

Chassis Weight

As a matter of fact, the 1917 chassis has not followed the curve of weight reduction which past trends would indicate. The abandonment of alloy steel wherever it is possible to get a reasonably satisfactory substitute of carbon steel may have something to do with this. Another reason for increased weight is in the deeper frame sections which are now employed, although this depth is necessitated by the longer wheelbase. The increased depth has been accompanied by a tendency toward longer springs of the half-elliptic type. The latter form of suspension in combination with the Hotchkiss and other

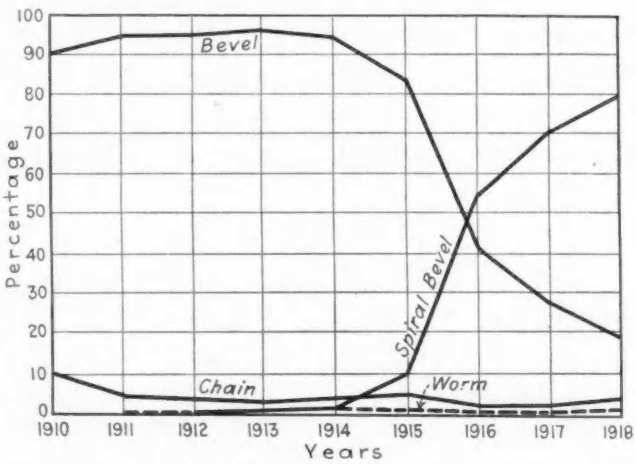


Fig. 7—Trend of Final Drive Design Showing Popularity of Spiral Bevel Drive

drives is growing in popularity. There remain only three cars which use full elliptic springs. Three manufacturers also continue to use platform springs, there having been a notable conversion in this respect of one of the companies making twelve-cylinder cars. Hotchkiss drive is used on 53 per cent of present-day American chassis.

Success of Light Clutches

Clutch adjustments continue to decrease. The success of the light types now on the market has been proved.

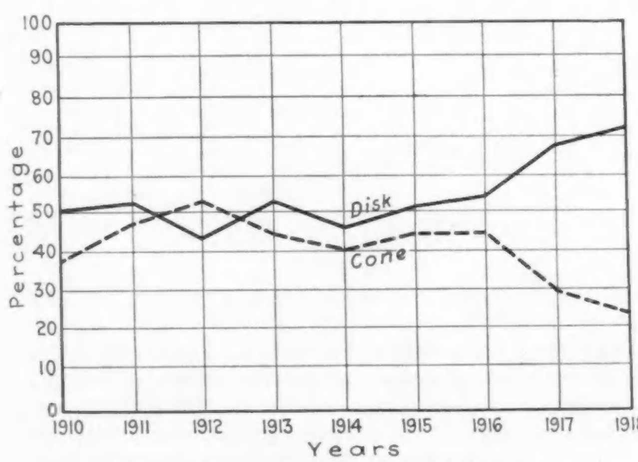


Fig 8—Disk and Cone Clutch Trends

Securing the lightest and most efficient clutch to transmit a given torque has been a problem studied very carefully during the past few years, and at present the disengaging method has become very light and quick. The fact that on some cars with powerful clutch springs the clutch pedal can be disengaged with the hand indicates how the travel of the engaging members has been shortened. The use of fewer disks has contributed to the shortness of travel, and is one of the factors contributing toward lighter clutches.

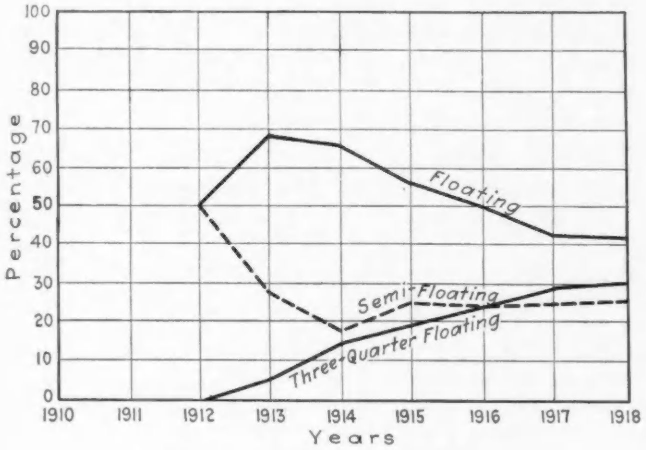


Fig 9—Trends in Rear Axle Design

Materials for Chassis Fittings

In chassis fitting a marked trend toward the more extended use of forgings for brackets and axle parts has been somewhat checked by the abnormally high prices asked for forgings at the present time. The result has been a temporary tendency toward increased use of malleable-iron parts. It is not probable, however, that this tendency is any indication of a permanent condition. Manufacturers have been forced, in some instances, to change from forgings to malleables, and in a few instances from malleable to steel castings, simply because of the difficulty in obtaining delivery of certain parts.

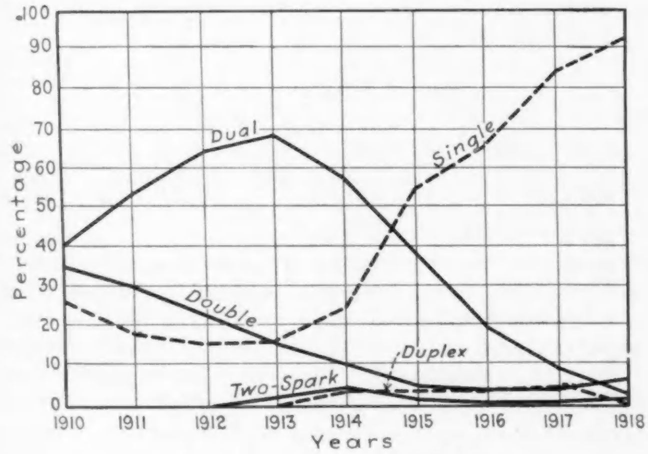


Fig. 10—Trends in the Applications of Ignition Systems

Further than this, in view of the present prices of forgings, malleable iron is being used for some parts where the size is a matter of convenience rather than of structural strength. In a great many trucks which ordinarily would employ forgings, practically all of the frame brackets, spring hangers and engine brackets are of malleable iron. All parts which are in tension, and particularly those which are under shock, such as rod ends, are made from forgings, if possible, and if not, from steel castings.

For the vital parts of all trucks and passenger cars forgings will continue to be used. This refers particularly to such parts as axles, steering connections and propeller-shaft parts. This condition has put a check for the time being to the trend toward forgings and stampings, but as soon as the war is over and conditions are relieved it is certain that the forgings and stampings will again come into their own.

A prominent engineer in charge of motor-truck construction in this country states that the following rules guide him in selecting cast-steel, malleable and drop forgings for small brackets, axle parts, etc.:

1. Cast steel is used for the more important structural parts that cannot be forged. It must be made fairly heavy to allow for segregation in the castings and blowholes. It should really be used only for complicated pieces.
2. Drop forgings should be used where very great strength with lightness is required.
3. Malleable iron should be used for unimportant structural parts, such as spacers, packing pieces and the like; parts where cast iron would probably be strong enough for the actual work to be done, but not strong enough to bear transportation and rough handling.

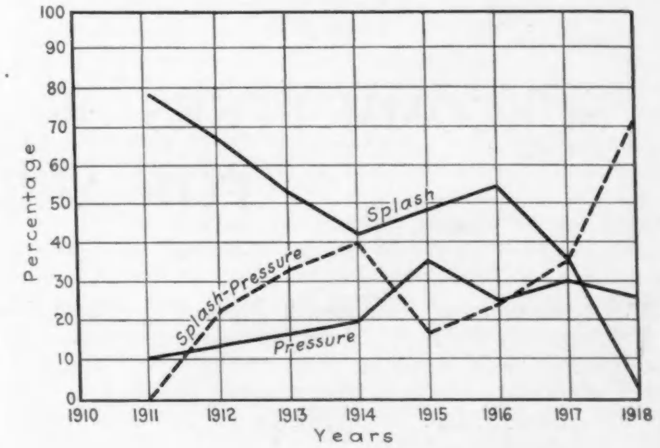


Fig. 11—Trends in Automobile Lubrication

4. In general, it is a wise rule to use forgings as much as possible, as after the first cost of dies they are usually found to be cheaper and much more homogeneous.

Body Lines Altered

Bodies generally have been altered only in exterior line. The beveled edge is typical. There has been a slight tendency toward improvement of the front compartment, a thing fought for in some quarters during the past three years. Where there has been a gain of additional space this has usually gone into the front compartment rather than the rear.

The color situation is better now than it was a year ago, although it is not easy to secure the desired pigments even now. A number of brighter colors are now in evidence, showing the tendency toward individuality,

particularly among manufacturers who make in the neighborhood of ten to fifteen cars a day.

One of the tendencies which may be predicted in body design is that the cars of the future, at least those of the touring variety, will be of the two, four or six-passenger type. This is highly desirable from the standpoint of beauty of outline, as it results in a car without the unsightly wheel housings. A two, four or six-passenger body can be swung between the rear wheels, giving a narrow line.

Body Improvement

There is still room for improvement in door fitting, even judging from an inspection of the cars on the floors of the show. This same condition held true last year. Doors will be tight on one side of the body and loose on the other. The shape of the backs of the seats can also be further improved, as the bulge of the back should fit the body. On the closed cars, and particularly the convertible type, a period of uncertainty seems to exist. Manufacturers do not know whether the majority of buyers want a permanent pillar or a removable pillar in the sides of the touring sedan models. This popular car has had a large sale this season, and will continue to have equal success next year, according to present indications. There has been considerable argument in favor of the permanent pillar in that it can be made lighter and at the same time more substantial. This seems to be a matter for education on the part of the purchaser as well as development by the manufacturer.

Manufacturers will do very well to wisely scatter throughout the country a few special bodies mounted on their stock chassis. There is always a market for these cars. They serve as very forceful advertising for the company, and can always be sold at an excellent profit. The dealer welcomes a car of this kind for his showroom, and it has been the experience of companies that have made these cars that there is always much competition between dealers to secure the special bodies.

Author's Summary

Summing up the entire situation, it may be said that we have come to a new era. The improvements in designing which have been traced up to the present time will serve as valuable experience to meet the new period which the war has brought into our national life and which is influencing our demands for transport equipment. The car which will carry its load with the least surplus car weight, with good acceleration ability, with no wasted length to add unnecessary weight, with an engine having an ample displacement, but one not too great for the load to be carried, in other words, a vehicle which returns the utmost in performance and comfort for the expenditure will be the one which will most surely meet the new state of mind of the purchaser.

Note—The curves accompanying this paper are published by courtesy of *Automotive Industries*.

SUBCOMMITTEES OF ADVISORY COMMITTEE FOR AERONAUTICS

The personnel of the subcommittees of the Executive Committee of the National Advisory Committee for Aeronautics was listed on page 290 of the November, 1917, Journal. Changes have recently occurred in some of the subcommittees, as shown in the following report of the present personnel:

Aero Torpedoes: Messrs. Towers (chairman) and Clark.

Aircraft Communications: Messrs. Pupin (chairman), Ames, Stratton and Rosa.

Airplane Mapping Committee: Messrs. Squier (chairman), Walcott, Bagley and Fisher.

Bibliography of Aeronautics: Messrs. Marvin (chairman) and Ames.

Buildings, Laboratories and Equipment: Messrs. Stratton (chairman), Ames, Durand, Clark and Towers.

Civil Aerial Transport: Messrs. Durand (chairman), Stratton, Marvin, Clark and Towers.

Landing Fields and Flying Routes: Messrs. Carl Fisher (chairman), S. S. Bradley, H. F. Talbott and W. W. Montgomery.

Design, Construction and Navigation of Aircraft: Messrs. Durand (chairman), Squier, Ames, Towers, Clark, Zahm (secretary), Alger, Hersey and Nelson.

Aeronautic Instruments: Messrs. Ames (chairman), Jewell, Hersey, Mendenhall and Briggs.

Editorial: Messrs. Ames (chairman), Stratton and Durand.

Free-Flight Tests: Messrs. Hayford (chairman), Durand, Stratton, Clark, Klemin, Briggs, Zahm, Webster and Lieut. G. P. Thomson, R. F. C.

Governmental Relations: Messrs. Walcott (chairman) and Stratton.

Helicopter or Direct-Lift Aircraft: Messrs. Durand (chairman), Pupin, Sellers, Wilson and Zahm.

Nomenclature for Aeronautics: Messrs. Ames (chairman), Clark, Hunsaker, Luther and Dickinson.

Power Plants: Messrs. Stratton (chairman), Squier, Durand, Towers, Dickinson (secretary), Riley, Newcomb, Atkins and Griffith.

Relation of the Atmosphere to Aeronautics: Messrs. Marvin (chairman), Ames, Hayford, Towers, Milling, Humphreys and Blair.

Special Committee on Engineering Problems: Messrs. Durand (chairman), Stratton, Zahm, Dickinson, Chase and Loening.

Standardization and Investigation of Materials: Messrs. Stratton (chairman), Ames, Squier, Durand, Hayford, Hunsaker, Nelson and Walen.

Light Alloys: Messrs. Burgess (chairman), Hunsaker, Norris, Manly, Blough, Jeffries and Mathewson.

Steel Construction for Aircraft: Messrs. Durand (chairman), Stratton, Zahm, Diffin, Stout, Nelson, Whittemore, J. W. Smith and Coates.

Society Governmental Activities

By First Vice-President Beecroft

Minneapolis Section Paper

THE growth of the Society of Automotive Engineers has been particularly rapid during the past year. The Society now has eight sections, and through these many of its activities are carried on. The oldest section is in New York, the largest in Detroit. At Detroit it is not uncommon to have five hundred people at the regular evening meetings. There are sections in Philadelphia, Indianapolis, Cleveland and Chicago. One was recently formed in Buffalo, and here in Minneapolis is the "baby" section—that is, in point of age, but not so far as power is concerned. Of the 3000 members of the parent Society, a great number are doing wonderful work in assisting the Government. This became so important it was necessary for the Society to open an office in Washington, which has been maintained since last April, in the Munsey Building. Hundreds of callers go there every week, many from the Government seeking men. One day the Society is requested for men for the Ordnance Department, another for the Quartermaster Department, another for the Signal Corps, and so forth. I do not believe there are any other two or three engineering societies in America that are daily cooperating with the Government to the same extent as the S. A. E.

Cooperation with the Government

We might cite a few examples. The two leading engineers connected with the Liberty engine, namely, Lieut. Col. Vincent and Major Hall, are members of this Society, and after these men had laid out the work many other engineers of the Society were called upon.

For the Liberty war truck design over forty engineers, nearly all members of this Society, went to Washington last July at the request of the Quartermaster Department, and worked continuously throughout July and August on those three models of war trucks, first the Class B, then the A, and then the AA.

Members of this Society are holding leading positions in the Ordnance Department at the present time. Past-president George W. Dunham is civilian chairman of one of the committees. Major Wall, a past vice-president, is one of the leading men; and Major Alden, another past-president, was sent to England to study the construction of tanks, and after spending several months there is now back in this country following that subject.

At the present time, two or three of our members are working in Washington with the Surgeon General on the development of ambulances and matters connected with them. Many members are also with the Engineer Corps. I do not believe there is a single department of the Government in which members of our Society are not cooperating on war work.

Some months ago an international committee was organized to develop a new aviation fuel, and on that committee were some of our members, collaborating with the Bureau of Standards and with representatives from England, France, Italy, and other Allied nations. In meetings at Washington they sought to establish a standardized fuel for aviation engines suitable for all the Allied aviators. This is expected to obviate all the confusion and trouble of delivering one kind of fuel for the Italian planes, another for the French, another for the British, and another for our own.

Only recently six of our members attended a great Anglo-American standardization conference in London. General Manager Clarkson was one of the party; Councilor Manly was a representative of our aviation activities; Mr. Diffin was chairman of that commission; Mr. Ehrman, one of the best authorities on screw-thread matters, was on it. They consulted with engineers of the Allied countries on many matters pertaining to standardization in connection with airplanes and in reference to the English standard of measurements as compared with the metric.

These matters are very creditable to us, indicating that our membership is taking the position of leadership in all of these not alone national but international affairs, and much of the good work has been developed in just such section organizations as this one.

Our members are also leaders in the standardization of motorboats. Second Vice-president Sutphen has done much standardization work on submarine chasers; in fact, he is the leading spirit in this field in this country at the present time.

In the Society of Automotive Engineers we believe we have the most enterprising of the engineers of America. We are a young Society compared with some of the others, and while our membership is 3000—numerically much smaller than others—in cooperation and action and accomplishment I do not believe another Society in America can compare with ours. And just such section meetings as this have made possible this get-together spirit. It was considered an impossibility for engineers to get together and successfully design an engine such as the Liberty engine, but that engine is more successful than anticipated. It is already being produced in great quantities, and one of the best proofs that the Liberty engine is meeting expectations is the fact that already three of our European Allies have ordered large quantities. They looked to America to develop something good, but they never dreamed that we could build a Liberty engine with twelve cylinders that would weigh very little over 800 pounds and deliver over 400 horsepower, which is a better performance than Europe has been able to develop, and is a design that lends itself admirably to production.

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Gears for Tractors

By A. W. Scarratt* (*Member of the Society*)

Minneapolis Section Paper

Illustrated with Charts

THE problem of gear teeth is one of the biggest that we have in machine design. To be sure it has had no small amount of investigation, but it is still in a chaotic state. Real data of an engineering nature, which are still lacking, would be of great value to all concerned with gearing problems and would aid greatly in conserving valuable material.

The subject will be treated mainly as it applies to tractor engineering problems, but first let us briefly consider the modern automobile and its transmission. About 95 per cent of the time that the automobile is in use, the power is delivered directly to the differential gear, the transmission gears not being called upon to transmit power. During the remaining 5 per cent of the time the transmission is required to deliver this power. Therefore, the actual period of use to which the transmission is put is exceedingly small, when compared to the actual life of the car. Even during this time it is very seldom required to transmit the full power of the engine. It is in view of these conditions that automobile transmissions can be built so lightly.

Automobile vs. Tractor Transmissions

The materials and workmanship, no doubt, are excellent, but the factor of safety is low when figured for full-load torque, and the factor of wear is still lower. The contrast is certainly great between these conditions and the demands put upon tractor transmissions and gears. A tractor will be used for approximately 1000 to 1500 hours in a year's time, which is about three times as long as the automobile is used, if driven 8000 miles in a year's time, and the transmission is required to deliver the power during the entire period of operation. It is safe to assume that during this time the tractor will operate continuously at not less than 80 per cent of its full-load rating. The automobile generally operates at from 15 to 25 per cent of its rated capacity. Therefore, by comparison, we find that a tractor transmission is required to do about 200 times as much in a year as the average automobile transmission, or, in other words, the tractor transmission sees more service in one year than the average automobile transmission would in 200 years. Therefore, when designing tractor transmissions, the most careful consideration and study are necessary. It is true that tractor transmissions have been heavy and crude, and that as a result the weight of the machines was high and the efficiency low, but it must be borne in mind that the large gasoline tractor of today is an outgrowth or revision of the steam threshing and road engine of twenty years ago, plus improvements, and not an offspring of the automobile. However, one cannot but realize the advantages of refined engineering and quality of materials and construction, and of standardization, as exemplified in the modern automobile, and it is for these reasons that there is such a revolution in tractor design.

*Tractor Engineer, Minneapolis Steel and Machinery Company.

Materials for Gears

From the foregoing remarks it will be seen, then, that when laying out the gearing, careful judgment and good engineering are essential, if high efficiency, minimum weight, and satisfactory service are to be obtained. Speed, torque, and space limitations, manufacturing facilities, and selling price, all have their influence on the type and the material of gears.

Table I—Materials for Gears

Material	Tensile Strength, Lb. per Sq. In.	Elastic Limit, Lb. per Sq. In.	Machining Quality	Characteristics
Close-grain cast iron	24,000	......	Cuts freely. Good surface	Easily obtained—low cost—satisfactory for low pressures.
Close-grain, semi-steel	31,000	......	Cuts freely. Good surface	Easily obtained—low cost—satisfactory for high or low speeds and low pressures—wears well.
Cast steel	60,000	31,000	Machines well when annealed	Medium cost—strong and tough—loss due to defects sometimes large. Wears well. Satisfactory for low speeds and low pressures.
* 0.20 carbon steel (S. A. E. No. 1020)	75,000	43,000	Care needed to avoid tearing	Affords good combination of strength, toughness and hardness—good for high speeds and medium pressures.
† 0.35 carbon steel (S. A. E. No. 1035)	95,000	65,000	Machines well when annealed	Good combination—strength, toughness and hardness. Good where high speeds or heavy pressures prevail.
† 0.45 carbon steel (S. A. E. No. 1045)	110,000	75,000	Machines well when annealed	Excellent strength but more brittle than the previous steel. Suitable for high speeds and for steady heavy pressures. Wears well.
† 3½ per cent nickel steel (0.20 carbon)	130,000	99,000	Hard to cut. Fine surface	Excellent strength, toughness and hardness. Very satisfactory for high pressures.
† 3½ per cent nickel steel (0.40 carbon)	155,000	130,000	Hard to cut. Fine surface	Excellent strength, toughness and hardness. Suitable for very severe conditions. Good for clash gears.
† Nichrome forging steel	150,000	130,000	Machines well	Same physical advantages as above—easily heat-treated. Excellent wearing qualities.
Chrome vanadium steel	190,000	150,000	Machines well	Same as previous steel.

*Carburized and heat-treated. †Heat-treated.

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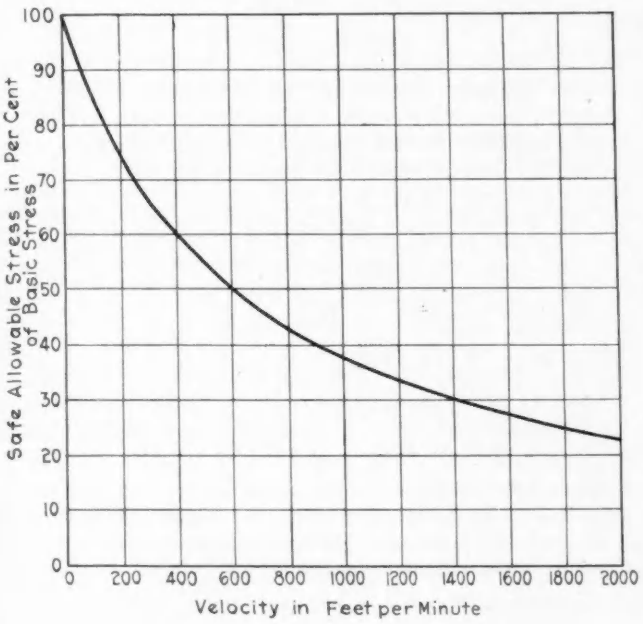
Of material the engineer has a considerable choice, and he also has several types of gear teeth from which to choose. Materials for gears range from paper, wood, cloth, hide and compositions to the finest alloy steels. Each has some advantage, be it strength, cost, operation, ease of production or wearing quality, and each tooth shape has some point in its favor.

Table I shows the tensile strength, elastic limit, machining properties, and other characteristics of several common materials suitable for tractor gears. The variations in strength is great, but actually it is even greater in practice than these figures show; when using metals of low strength, the factor of safety must be larger than is required when using metals of greater strength, because of the variance in physical properties to be found in the lower grade materials. The physical properties of any of the carbon steels and alloy steels can be varied considerably to suit the designer's requirements, so that the figures given do not apply to all cases. The strength desired is regulated in the heat treatment by the drawing temperature used, the low drawing temperatures giving steels of high tensile strength and high elastic limit, and good hardness, but at a sacrifice of some of the toughness. The higher drawing temperatures decrease the tensile



Values for Factor "S" in the Lewis Formula for Strength of Gear Teeth

Safe working (basic) stress for various materials, lb. per sq. in.

Rawhide	5,000	Bronze	12,000
Cast iron, Cloth	8,000	Cast steel	20,000
Semi-steel	10,500	Forged steel (not treated)	25,000

strength, elastic limit and hardness, but will materially increase the toughness. Therefore, in choosing the material for a gear, careful consideration must be given to securing the proper strength for the loads imposed upon it, proper hardness to insure reasonable service and proper dynamic properties to resist impact and fatigue. Here is where we lack much information.

Certain materials seem to be satisfactory for automobile gears, in view of the small amount of service they get, but it is questionable if gears made of similar proportions and of the same materials working under full-load torque all the time, and, therefore, under much greater surface pressures, will last as long as they should in tractor service. It seems to the author that experiments should be made to determine definite data on the relation of surface pressures and the degree of surface hardness necessary for a given length of service. These properties must bear some reasonable relation to one another for any given material. Certainly private investigations have been made which would be of great value if given to the engineering profession.

Strength of Gear Teeth

There is also much information lacking on the subject of the strength of gear teeth. On account of the various shapes of teeth, no common rule can be used in figuring their strength and the problem becomes a complex one. For instance, we have the Brown & Sharpe 14½-deg. tooth, the Grant 15-deg. tooth, and a 20-deg. tooth, all of which are of equal length and which agree in all proportions excepting the pressure angle. This, of course, varies the strength of the tooth in the ratio of the squares of the root thickness. The root section is the critical one of the tooth when figured as a cantilever beam, the load being applied at the outer edge of the tooth. In a rack gear of any given width, the 20-deg. pressure angle tooth is practically 25 per cent stronger than the 14½-deg. tooth. This ratio is not constant, however, in fact, it becomes slightly greater as the number of teeth in the gear becomes less. This is one advantage in favor of the 20-deg. pressure angle.

The most commonly used formula for these particular types of teeth is that originated by Wilfred Lewis, where

$$W = SPFY \frac{600}{600 + V}$$

in which

W = Safe tooth load in lb.
S = Safe stress in lb. per sq. in.
P = Circular pitch, inches
F = Face, inches
Y = Factor depending on the number of teeth in the gear and the pressure angle used.
V = Velocity in ft. per min.

The factor Y is governed entirely by the number and shape of the teeth. Tables of these values are given in all engineering handbooks. The values of S for different materials and velocities are given in the accompanying diagram. These values I believe are subject to criticism because the allowable stress drops with an increase in speed in the same ratio for every material regardless of its physical properties. This certainly should not be the case. When we consider the ability to resist impact forces of materials, such as chrome vanadium steel, and the inability of other materials, such as cast iron, their classification in the diagram seems absolutely foolish. In fact, several large manufacturers today do not adhere to the Lewis recommendations for the allowable stress.

Previously, when considering the strength of the gear tooth, we have seen the value of increasing the pressure angle. Another way of increasing the load-carrying capacity of the tooth is by shortening it in a manner similar to the Fellows 20-deg. stub tooth standard. The word standard as applied here is a joke, as the so-called Fellows system is far from a standard. However, the designers of that system realized the value of the short tooth and made a system of tooth sizes in which the addendum, dedendum, and clearance of a small tooth is combined with a tooth of large pitch. The Fellows stub

tooth system comprises the following tooth sizes: 4/5, 5/7, 6/8, 7/9, 8/10, 9/11, 10/12, 12/14.

It will be seen that there is no definite ratio between the height of the tooth and its pitch, such as prevails in the Brown & Sharpe system.

Another disadvantage with the Fellows system is that the range of tooth sizes is not adequate, especially in tractor work. The author has been forced on several occasions to use stub teeth of larger pitch than any given in the table, these sizes being the ¾ and 2/2½ pitch. Another disadvantage in the present stub-tooth system is that no convenient or accurate formula is available for figuring the strength of the teeth, and there cannot be one until considerable investigation has been made. Why should we not have a standard 20-deg. stub tooth which has definitely fixed proportions based on the pitch, such as is exemplified in the 20 deg. stub tooth proposed* by Charles H. Logue?

The customary practice has been to figure the strength of the regular 20-deg. tooth and then increase this strength in the proportion of the inverted pitch fraction of the stub tooth. This does not give the correct strength, as it assumes the root thickness of the full-length tooth and stub tooth to be alike, and this is not the case. The root thickness of the 20-deg. stub tooth is less than that of the 20-deg. full-length tooth of equal pitch measure, and consequently it has a smaller section modulus.

In thus harshly criticising our present gear-tooth practices, it is hoped that a general discussion of the subject will result, with a view of bringing out valuable information on the subject.

The author feels that there is room for much enlightenment through research work on this subject, if we are to use our valuable resources to the best advantage.

THE DISCUSSION

H. C. Buffington:—It seems to me that there is just as much difference between cast iron and chrome vanadium steel as between steel and wood; it is my opinion that in the standardization of gear teeth engineers always have fallen down. There is no standard. When we instruct a draftsman to lay out a gear he probably will take some standard that we did not have in mind at all; and when we tell him to lay out a stub-tooth gear and have another man check up his drawing, they will each have a different result. Another person checking the same drawing will probably get another result, so it seems that teeth forms are still unstandardized.

I do not see why engineering societies cannot jointly adopt some form of stub tooth so we can have interchangeable gears. The electric starter on an automobile is very small; it is really too small for the larger engines if it is going to be used on tractors in the future. Not long ago I was laying out the gear teeth for an electric starter on a large engine and I found that it was necessary to employ a 7/9 pitch or one a little larger. That is drawing right away from the automobile form because in order to get a tooth that is strong enough for cast iron it is necessary to use the larger stub tooth, and then the question arises as to what stub tooth we are going to use. I suggest that we outline some standard tooth before going too far into the electric-starter proposition, and the same remark applies to many other gear forms and transmissions.

*In *American Machinist*, June, 1907.

Chairman E. R. Greer:—If standardization is necessary and to be adopted there must be teeth of the same pitch on every tractor flywheel if we are going to make starters interchangeable. Automobile manufacturers have standardized small gear teeth.

Mr. Buffington:—Steel ring teeth.

Chairman Greer:—If manufacturers have done that, naturally the starter people would want to use the same standard for the larger pitch, but the larger pitch would not be a standard that any automobile people are now using. Even in transmissions, where each tractor company is making all of its own gears, there would be quite an advantage in a standard tooth. In purchasing cutters and in checking teeth there would be a great advantage in having all gears the same.

G. C. Andrews:—In reference to the chilled-iron tooth, we get wearing surface on our coarse work and strength and hardness, but we do not get toughness. I would like to know if there have been any experiments along these lines. With reference to lubrication, when we reduce pressure surface, will it not become so small that the lubricant will have little life, soon becoming spoiled? Last summer I was looking up some tests for transmissions and it was a surprise to learn that there is almost no gain in lubrication when using a large gear.

F. McDonough:—When we heat-treat gears we will find that the loss in heat-treating is much less with the stub-tooth gear than with the old long tooth. There is a great tendency to use stub teeth for the reason that they do not lose as much in heat-treatment.

A. Krieg:—Some time ago I asked tractor companies about the addendum and dedendum of their teeth and they told me they were three-quarters of a standard tooth; the clearance is the same as the clearance of the standard tooth, which is one-twentieth of the circular pitch. I do not see why having the addendum and dedendum three-quarters of a standard tooth would not be satisfactory for tractor work. It is generally used now. I believe all cutters are standard, and if we change now to another standard it would be difficult to get cutters.

Chairman Greer:—I think you are right about the impracticability of any change; the matter has gone so far that the Fellows are all we can use. Are you sure about the proportions being right?

Mr. Krieg:—They are not exactly right. With the larger ¾ pitch, three-quarters of the ordinary tooth can be used. Take the double addendum, multiply it by 0.75 and then make the clearance the same as on a standard tooth, which is one-twentieth of a circular pitch. I think that works out well.

Mr. Buffington:—Would you express the stub-tooth pitch as a fraction? Would you not have to express it as a decimal?

Mr. Krieg:—That is one mistake they evidently made.

Chairman Greer:—It works out pretty well until we get into the half pitches in the large sizes. It is a big jump from the 3 pitch to the 2 pitch. Naturally 2½ pitch must be used but when we get into half pitches then we strike a peculiar combination.

Mr. Scarratt:—If we have a massive gear that we want to heat-treat to get a good surface hardness, we will in all probability have to change the drawing tem-

perature and also the medium used in drawing. Oil, brine and plain water are used. The oil does not have the quick effect on the treatment of the gear of either brine or water, and in most of the carbon steels listed the drawing temperature would range probably anywhere from 450 up to 1200 deg. and the drawing temperatures used in these stated values would be about an average of the two. If the maximum strength and hardness are desired in a gear and the dynamic properties are not to be given such great consideration, for instance where the loads are very constant, a lower drawing temperature could be used, which would give high tensile strength and elastic limit and a harder gear. But in tractor service we have a severe problem to contend with. The shocks are great and they are intermittent, and as the tractor might be operated for long periods without rest it is not safe to work gears up to the maximum tensile strength and elastic limit. We must consider seriously the toughness of the steel and its ability to withstand the impact loads that we get and that will necessitate drawing the steels at a little higher temperature than for the other stated condition. The exact range needed for those gears would be hard to determine. The values given in the paper for the carbon steels and the nickel steels were taken from the specifications in the S. A. E. Handbook and are about medium values throughout.

Factors of Safety

A MEMBER:—What factor of safety is used?

MR. SCARRATT:—That is a matter of opinion. If the gears are put into very severe service where the shock load is going to be tremendous, such as in tractor work, it is not unreasonable to suppose that at times the load on a tractor will exceed the maximum rated load of the engine by 100 per cent. If that were true, in other words, if we did not think that the shock load would set up such a high stress in the gears that the brittle point would be reached, but that there would be a permanent set and a possibility of rupture in the teeth of the gear, then a basic stress at least 50 per cent lower than the elastic limit given would have to be used. If gears are put into use where they are not going to meet such conditions as that, stresses which run nearer to the elastic limit can be used. That is largely a matter of judgment. Definite figures cannot be given. In view of that, treating with the lowest safe working stresses is conservative.

MR. ANDREWS:—What is conservative, the 4 or 5 or 6?

MR. SCARRATT:—In tractor work I should say that if stresses were taken as, say, 50 per cent of the elastic limits of the stated material, we would not be too high for the different gears. That stress would be for a static load—practically no speed—and if stresses in accordance with the values plotted in the Lewis curve were taken we would be very safe at the higher speeds owing to the ability of these better grades of steel to withstand shock as compared to such materials as cast iron and semi-steel for which that curve is suitable.

MR. ANDREWS:—If a spring is put in to take care of shocks, as on the new Foote tractor, can any allowance be made?

MR. SCARRATT:—I do not believe so.

Effect of War Factor

CHAIRMAN GREER:—When values for wear are figured out, is it not true in almost every case that the teeth are considerably larger than needed for tensile strength. Does not the wear factor insure having sufficiently large teeth?

MR. SCARRATT:—We know less about the factor of wear in gears than we do about the strength of materials.

CHAIRMAN GREER:—If we design a gear for a known load and figure a factor of safety of 2, that would be 50 per cent of the elastic limit and I am sure we would have a pretty small tooth for anything we might want to consider in a tractor. We would probably decide to have it four or five times as large as that unless we were using cast iron. With good steel it would be small.

A. F. MOYER:—How would one start out to experiment as to wearing of gears and gear teeth?

MR. SCARRATT:—As stated in the paper, I think we know less about the factor of wearing than of any other gear factors. Automobile transmissions have stood up well. The gears will probably last longer than a machine, as a rule, and their long life is because the work done is relatively so little in comparison with the life of the machine. Whether we could take gears of similar proportions to those used in automobile transmissions and put them in tractor transmissions which, as I stated, would get possibly 200 times as much service in a year as an automobile transmission, it is very questionable if the gears would last nearly as long. Gear and transmission manufacturers certainly must have run gears of given sizes and of various materials under maximum loads for a long period of time in order to determine the amount of wear and the surface pressures that they could reasonably stand, but no information of that kind is available.

It would not be a hard problem to figure the strength of a gear and compute the necessary size if we only knew how much pressure that gear was able to take under continual service and still stand up for a reasonable length of time. The only way that I know of for finding it is to take sets of two small gears of various sizes and of various materials, first test the materials, and then run them continuously for a thousand hours under the rated load for which they are computed and then measure the amount of wear on the teeth.

TESTING GEARS

MR. MOYER:—I looked up all the data I could find from various sources. As far as I know, the published experimental data are based entirely on the running of cast iron gears. A proposal was made to test gears by running them in some machine that would place pressure on the teeth, but this would not solve the entire problem. If we take four gears we can mesh all four so they will fit only in one position, depending on the number of teeth. To distort the centers, we move any of the gears a little and apply pressure. If we were to take a chain of gears like that and apply pressure diagonally on opposite sides of the square and run them for a long time to find the amount of power necessary to overcome the friction, I think we could get some good data on the pressure.

MR. SCARRATT:—We went through a little experimental work of that nature. We put a set of bevel gears in the differential of a machine and gave that machine a long run. It had approximately 350 hours of continuous service, all told, and we then removed the differential from the machine to see the condition of the gears. They were stub tooth gears of the best semi-steel we could make and were very accurately cut. We found that

in 350 hours of service a full thirty-second of an inch of metal had been removed from the faces of the teeth. They were worn perfectly as to shape. The action was just a crushing from the gear surface. Now, with any amount of figuring, that would appear to be a perfectly safe gear and it was running submerged in oil continuously, but the surface pressure was in excess of what the actual strength of the material would stand.

MR. MOYER:—What were the pitch and tooth pressure of those gears?

MR. SCARRATT:—It was a 4/5 stub tooth bevel gear, 12 inches pitch diameter. There were four pinions in the differential and I believe that the torque on the mean pitch radius would be approximately 2800 or 2900 pounds.

MR. MOYER:—What was the face of the gears?

MR. SCARRATT:—A $1\frac{3}{4}$-in. face.

Vibration and Dirt

CHAIRMAN GREER:—In tractor work the vibration and dirt conditions must be considered. In any laboratory test they would be run clean and it would be foolish to make a test that way. Running them without vibration would make a tremendous difference. Slight vibration might make a difference of three or four times in the life of the gear. As Mr. Scarratt stated, the gears that he mentioned failed from crushing and if a gear will fail from crushing any vibration would certainly affect the wearing of the material.

MR. SCARRATT:—In modern tractors we have arrived at the conclusion that cast iron has no place in any kind of transmissions or gears, that is, for tractors designed for the minimum of weight and the maximum of power and efficiency.

A MEMBER:—What about the use of manganese in gear material?

Ferro-Manganese

MR. HATFIELD:—Ferro-manganese contains about 15 per cent of manganese. It is a manganese and iron alloy of great strength and is being used quite generally in all sorts of mechanical constructions where resistance to wear is required. It undoubtedly would be an excellent material for gear teeth where resistance to wear is required.

A MEMBER:—What about machining?

MR. HATFIELD:—It is absolutely non-machinable.

A MEMBER:—That eliminates it for cut gears.

MR. HATFIELD:—It has to be cast. It has a tensile strength of about 80,000 lb., elastic limit about half that, it is comparatively soft, hardness about 250, but is wonderfully resistant to abrasion.

Cast Iron Inserts

O. W. YOUNG:—In tracklaying types of tractors, particularly in the case of the Yuba and the Best, manganese drive sprockets are used. Some holes must be drilled in the hub bearings so inserts of cast iron are cast in the manganese steel at those places, and the holes are drilled in the cast iron. Whenever anything must be fastened to the gear a little cast-iron is employed in this way.

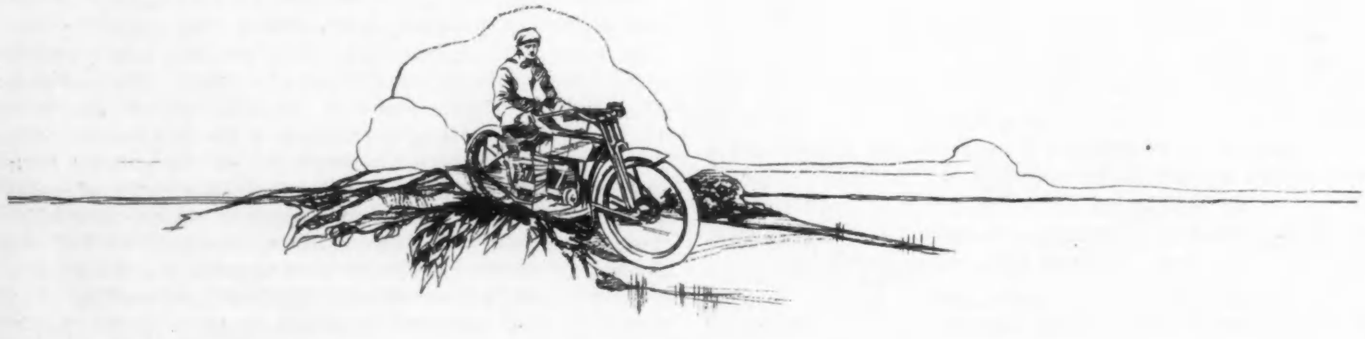
CHAIRMAN GREER:—Is the track with which this gear engages of manganese steel?

MR. YOUNG:—No. Different materials have been used. Manganese track rings have been used for dredges, but they were not necessary. An alloy steel bull pinion is used.

CHAIRMAN GREER:—Do they machine the pinion and cast the gear?

MR. YOUNG:—Yes, the pinions probably wear out five to one.

J. H. NEAD:—Referring to Mr. Moyer's suggestion of a mechanism for testing gears I recall the time a test on gears was under way at an arsenal. They were having much difficulty with traversing gears on disappearing carriages. They had a gear train rigged up, consisting of four gears arranged in a rectangle. Gear 1 was driven by a belt, gear 1 drove gear 2, gear 2 drove gear 3 through a shaft and gear 3 drove gear 4, and there was a drum between gear 1 and gear 4 with a spring in it which applied tension to the gears throughout the train. It struck me as a good method of testing gears. It was mounted in a basement close to a coal bin where there was plenty of dirt.



Economic Size of Farm Tractor

By Ernest Goldberger* (Non-Member)

Mid-West Section Paper *Illustrated with* Charts

A COUPLE of years ago a study of the cost of plowing with tractors would not have been of any practical value. The conclusions, even though they might have been drawn in the most logical way, would have been theoretical, because based upon theoretical assumptions.

During the last few years the line of tractors has been extended until now we have on the market practically any size of tractor, ranging from 10 up to 130 hp.; knowing their performances and prices, the requirements on the farm and the manufacturing problems—that is, all the premises being known facts—it is possible not only to draw correct conclusions referring to the present conditions, but also, what from a business standpoint is more important, to anticipate the future development.

Many students of this problem will undoubtedly say conditions on the farms are so different as to the quality of soil, size of farm, kind of crop, and hundreds of other things, that, everything considered, a general and intelligent solution of the problem is precluded, while without taking everything into consideration the solution cannot be correct. That is, at least, as it appeared to me a couple of years ago, but I have changed my mind in the meantime.

One way of attacking the problem is by "national referendum"; that is, by having every tractor owner state the size of his tractor and farm, perhaps also the size he thinks would suit him better, and draw the conclusion according to the law of averages. The Department of Agriculture has published the results of such an investigation, directed by A. P. Yerkes, and although based on different methods the results of the survey agree with the conclusions that follow the thought of this study.

In the following I shall consider three sizes of tractor that would be built along exactly the same standards of quality, design and workmanship:

A—Capable of pulling two 14-in. plows, 6 in. deep, in average soil, at a speed of $2\frac{1}{2}$ m.p.h. This would require about 9 hp. on the drawbar.

B—Same quality tractor, of double size, pulling four 14-in. plows, 6 in. deep, in the same soil, $2\frac{1}{2}$ m.p.h. speed. Drawbar of 18 hp.

C—Twice as strong as B, pulling eight 14-in. plows, 6 in. deep in the same soil. Drawbar 36 hp.

Estimated Costs

Since there is today no doubt in the mind of anybody familiar with the tractor problem that really successful tractors are and must be built according to the standards of quality adopted by truck manufacturers, and not by country blacksmiths, I shall estimate the prices as follows:

Initial Costs

Tractor A, \$600; Tractor B, \$1,500; Tractor C, \$3,600. The price for Tractor A, if the design, material and workmanship be first class, cannot be reached unless quantity-production methods are adopted. For 100 per cent increase in size the price increases 150 per cent in the above estimates, since I make the preliminary assumption that with the size of the tractor increasing the demand might decrease and the manufacturing methods to be adopted become more expensive.

I shall not consider the cost of plows and other equipment, since for a comparative study of the cost of plowing with different sizes of tractors it matters very little.

Cost for Operator

A two and a four-bottom tractor and plow can easily be operated by one man, while for an eight-bottom tractor two men are necessary; not for lifting and lowering the bottoms, which can be done automatically, but for cleaning and unclogging the plows, which would mean stopping the machine often if this work were to be done by the man steering the tractor.

The expense for operator would therefore come to 30 cents per hour for the two and four-plow outfits, and 60 cents for the eight-plow outfit.

Fuel Cost

Experience has shown that the fuel consumption of gasoline tractors per horsepower hour changes little or none with the size of engine, provided all are built according to the same standards and are run at the same percentage of load. In our case, the cost for fuel (and oil, etc.) should be, for tractor A, 25 cents per hour, tractor B 50 cents per hour, and for tractor C \$1 per hour.

Depreciation

One often hears the statement that a tractor will last five or six years. Such a statement is fundamentally wrong. A tractor, or any machine in general, depreciates because of, first, the wear and tear of the machine, a factor altogether independent of the age of the machine, the only thing affecting it being the actual working hours; and second, the obsolescence, which, on the contrary, depends upon the age of the machine and not upon the working hours. The last factor is more important than the first in automobiles or any products subject to change of style, but with utility products it has little importance, unless a new invention changes fundamentally the existing conditions. Yet, even among automobiles, the Ford car, model T, has not become obsolete after ten years of use; and I know of American tractor manufacturers who have not improved their tractors materially since 1911-12, and are now selling more tractors of the same type in a month than they made all told up to 1915, while some of the machines they sold in 1912 are still "going strong." Therefore, it is appropriate to base the allowance for depreciation upon the total actual working hours of a tractor, provided it be of progressive design, and not upon total life. This should apply satisfactorily to horses, or any draft animals whose average life is nearly constant whether they work or not. It is a conservative

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estimate to say that tractors of modern design, of any size, will be good only for about 4500 hours of plowing; this would give a tractor, plowing 10 hours a day, a life of 5 years. Should the tractor plow only 45 days per year its life would then be 10 years, provided no other work but plowing is done. This estimate is safe, since

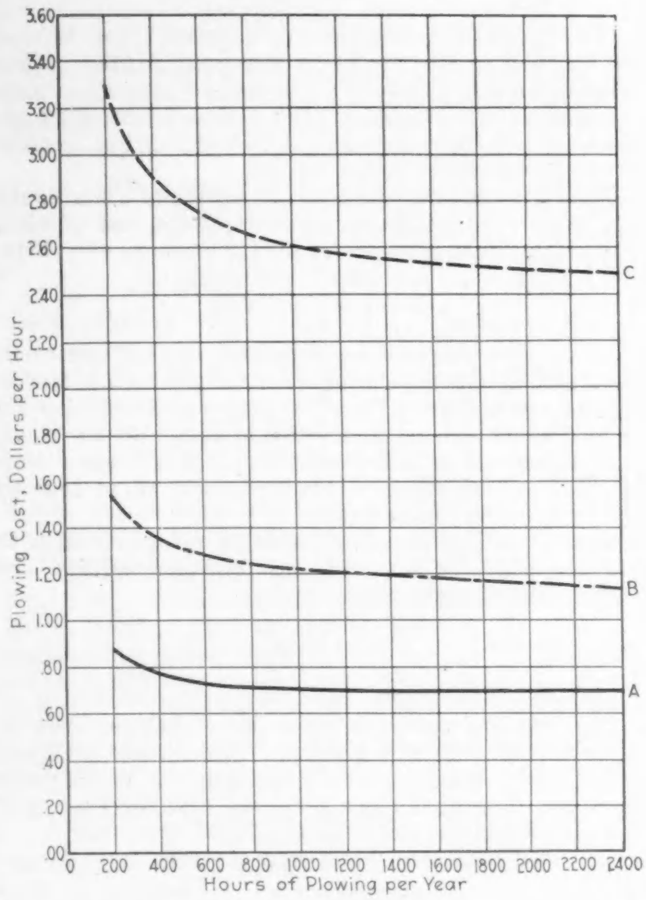


FIG. 1—APPROXIMATE COST OF PLOWING PER HOUR FOR THREE SIZES OF TRACTORS
A, two-plow; B, four-plow, and C, eight-plow

80 per cent of its value has already been figured in the item for wear and tear, and part of the remaining 20 per cent can easily be recovered by the sale of its high-grade material as junk.

For tractor A the depreciation per plowing hour can be figured at 600/4500 = \$0.13; for tractor B the figure is 1500/4500 = \$0.33 per plowing hour; for tractor C at 3600/4500 = \$0.80 per plowing hour.

Repairs and Interest

These two factors are considered together, and estimated at 6 per cent per year on the initial price of the tractor. Since the value of the tractor decreases constantly, the interest on this value also decreases. If it is assumed that the tractor will last 6 years, the interest during the first year will be 6 per cent on the price paid; the following year it will be 6 per cent on the present value of the tractor, or 5 per cent of the total initial price; and so on. The allowance for interest and repairs being 6 per cent per year on the total initial price, the result is that no repair allowance is made for the first year, 1 per cent of total initial value is taken for the second, 2 per cent for the third, and so on; such an estimate corresponds with the actual conditions as they occur with tractors of modern design.

COMPARISON OF PLOWING

Suppose we figure every one of these items for the tractors chosen for a variable number of actual plowing hours per year; in Fig. 1 the abscissas represent the number of actual plowing hours per year, and ordinates the cost of plowing per hour; the curves marked *A*, *B* and *C* correspond to the machines above mentioned.

Fig. 1 does not give a final indication as to the comparative cost of plowing with the different sizes of tractors, but is used in making Figs. 2 and 3. Fig. 2 gives the relation of cost in dollars per acre to the number of hours of plowing. Tractors A, B and C are supposed to pull 2, 4 and 8 bottoms respectively, 14 in. wide, 6 in. deep, at a speed of 2.5 m.p.h. It is assumed that the tractors will plow only 85 per cent of the time they are in the field, 15 per cent being the allowance for turning the headlands, oiling, trouble, etc. The area actually plowed is calculated as 0.6, 1.2, or 2.4 acres per hour respectively. The small figures along the curves represent the number of acres per year the chosen tractor would actually plow.

From Fig. 2 as a basis, Fig. 3 has been drawn, and this gives the final information we are after. We read the area to be plowed in a year on the abscissa, follow the ordinate until it intersects the curve representing the A, B and C tractor, and then at the left we read on the ordinate the cost of plowing per acre.

If we have to plow less than 250 acres per year, and not deeper than 6 in., the tractor with 9 db-hp. plows the

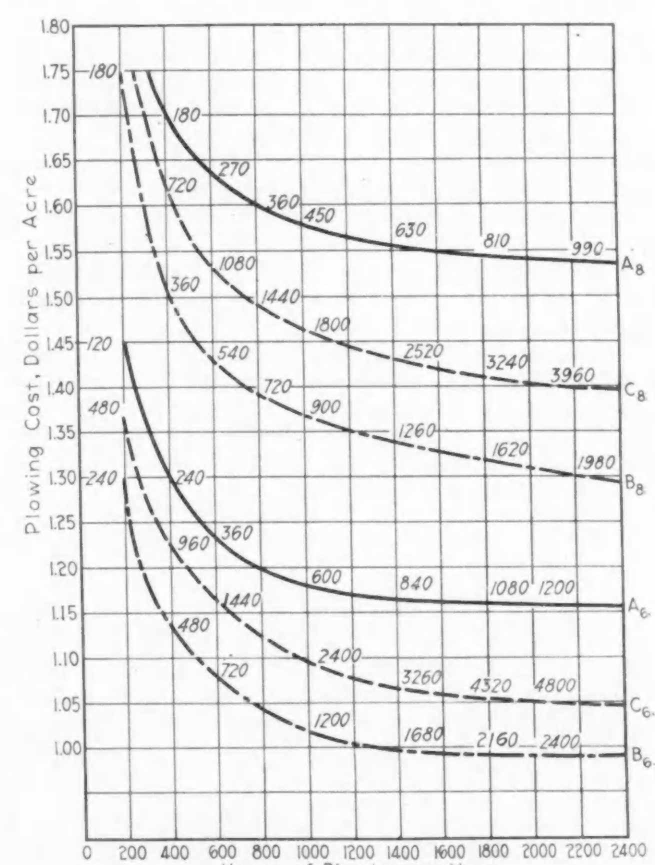


FIG. 2—APPROXIMATE COST OF PLOWING 6 AND 8 IN. DEEP WITH THREE SIZES OF TRACTORS
A, two-plow; B, four-plow; C, eight-plow. Figures above curves show number of acres plowed in corresponding time

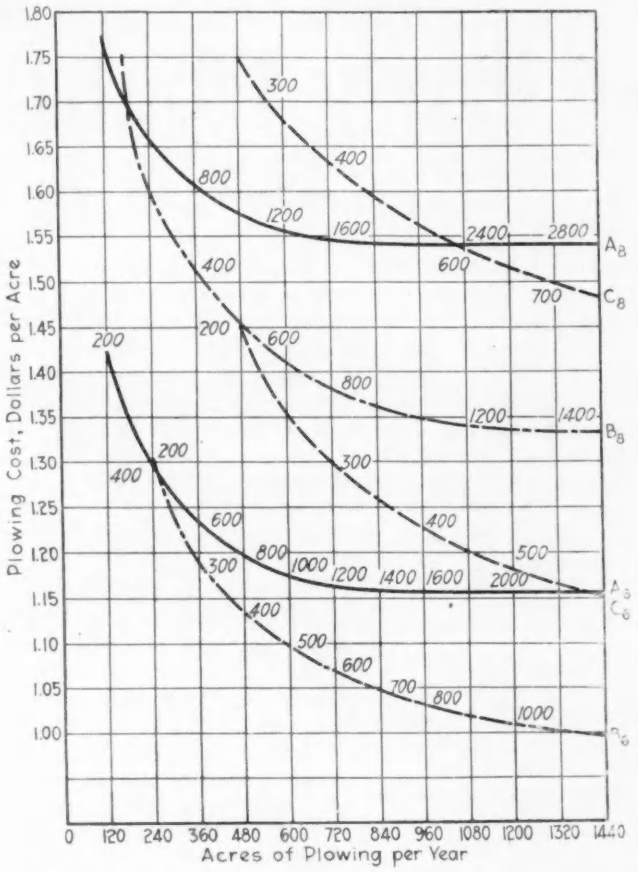


FIG. 3—CURVES FOR SELECTING ECONOMIC-SIZED TRACTOR FOR ANY NUMBER OF ACRES, WITH TIME REQUIRED AND COST

cheapest; for anything above this amount, the four-plow tractor with about 18 db.-hp. is the cheapest in the end; while even for farms so large that one four-plow is too small, it pays better to have two four-plow tractors than one eight-plow tractor. The advantage of having two smaller powerplant units instead of one large one, or the matter of flexibility, is not considered at all in the charts.

COST OF PLOWING

The chart shows much more than this. It shows how much cheaper the plowing is if there be much of it to be done, or in other words how expensive it is to be poor. There are, however, two ways by which the small farmer can compete with the big one without having to buy his neighbor's land: by deeper plowing and by plowing early and quickly. To meet both of these conditions the two-plow tractor will give way to the larger one; in fact, from the upper curves, representing the cost for plowing 8 in. deep, we find that for above 180 acres of plowing per year the four-plow tractor is the cheapest. For 240 acres of plowing per year the four-plow tractor is only a little cheaper in dollars and cents, but it has the advantage that it performs the work in about 30 days instead of 60, as is necessary with the smaller one.

Increasing the Depth of Plowing

Now, there are two ways of making a tractor intended to pull four bottoms 6 in. deep plow 8 in. deep. First, by hitching three plow bottoms instead of four; second, by leaving the four on and plowing at a speed of about 1.9 m.p.h., which every tractor should have, instead of at 2.5 m.p.h.; the area plowed per hour and the cost are then nearly the same. In fact, there is a great advantage by applying the first method, since we cannot count on using the full power of the tractor continually where its efficiency is highest. Hard spots on the land, or grades, will be overcome by shifting to the low-speed gear. On the other hand, with a two-plow tractor, intended for plowing 6 in. deep, we have no other choice, if extra expense for specially narrow bottoms is to be avoided, but to run the plows 8 in. deep on low speed all the time.

AUTHOR'S CONCLUSION

Manufacturers have too long likened the tractor to the truck manufacturing problems. There is good reason for building four or five sizes of trucks in the same plant. Sometimes a 5-ton load cannot be handled by either one or two 3-ton trucks, nor is it economical to run a 3-ton truck with a 1-ton load; but in plowing the load can be easily adapted to the full power of the tractor.

It is important to note that a conclusion has been reached in favor of the four-plow tractor, although the preliminary assumption was made that the two-plow tractor will probably be the most popular type, and therefore the cheapest to manufacture. But since we have reached the conclusion that the four-plow outfit is the most economical it can be expected that, owing to its production in large quantities, its price per horsepower will not be 25 per cent higher than that of the two-plow outfit, as assumed at the beginning of this analysis, but perhaps even lower.

Reminiscences of Early Flight

By E. W. Roberts (*Member of the Society*) *Illustrated with* Photographs and Charts

THE first power flight of an airplane was not, as many suppose, that made by Ader in France in 1897. The first mechanical flight by any form of power was made by the large steam-powered machine designed and built by Sir Hiram Maxim (then Mr. Maxim). This flight was made about 3 o'clock in the afternoon of July 31, 1894, at Baldwyn's Park, about halfway between Bexley and Dartford, in the county of Kent, England. The author was so fortunate as to be present at that flight, as he was Mr. Maxim's chief assistant on this work at the time.

I had seen an account of Mr. Maxim's machine in the *Cosmopolitan Magazine* and, as I was very much interested in aeronautics, I asked his permission to spend a few months with him during the summer of 1894, and received a very cordial invitation to join him. I reached Baldwyn's Park on July 10 and spent the summer and the greater part of the fall and winter on this work.

The following account of Mr. Maxim's machine and his experiments is from notes made at the time, and which I have before me as I write. Mr. and Mrs. Maxim greeted me with a very cordial welcome on my arrival, and he took me to see the machine, which was housed in a large wooden building, called the "factory." This building was about 60 ft. wide, 80 ft. long and about 45 ft. high. The factory was equipped with a couple of lathes, a small shaper and a milling machine, and, if I remember rightly, a small bench drill. The machine itself was, naturally, the center of interest, and it reminded me of nothing so much as a large kite, tied down to several steel pillars by a bundle of wires.

Sir Hiram Maxim, a Pioneer Aeronautical Engineer

Dimensions of the Planes

The main airplane sail (it could hardly be called a wing) measured 35 ft. from front to back and 50 ft. across. This is what would be called the center section in a modern machine. The front edge of the main plane was elevated and given a pitch of 1 in 8. I am unable to give the exact curve, but the cross-section was very similar in shape with what would be an average curve in a modern wing, but, of course, it was not so scientifically fashioned. This plane was built up on a framework of steel with light wooden ribs, just as in a modern machine. The covering was a cotton fabric, which Mr. Maxim secured from a London balloon maker. It was of very close mesh. My notes state that the cloth was varnished with a mixture of turpentine and boiled oil, but my recollection is that the varnish was paraffine dissolved in gasoline. At least, I know that paraffine was used on several occasions to varnish the planes. The planes were double-covered and the under side was given a very light coat, so that it would allow the air to percolate through. Mr. Maxim's idea was that by making the top covering as nearly airtight as possible and the under covering porous, the air would pass through, the latter giving a practically even pressure on both sides preventing pocketing between the ribs, on the under side.

My observations, on the ground, seemed to show that the plan worked very well in practice. Besides the main plane, the machine, when in full rig, had two planes extending from each side and set at a dihedral angle with a slope of 1 in 6 to the horizontal. There was an elevator forward and one aft. The front one was called, by the workmen, the "beak" and the rear one the "rudder." It was planned to attach these elevators to a steam steering-gear controlled by a steam gyroscope, but these elevators were never used in the experiments, the operating cables being made fast. There was no horizontal rudder of any kind. Mr. Maxim's plan was to steer the machine in a horizontal plane by means of the engine throttles, running one engine faster than the other. Besides the five main lifting surfaces, Mr. Maxim had others prepared and expected to place them between the upper and the lower side wings. All of these side wings, with the exception of the lower, were double-covered.

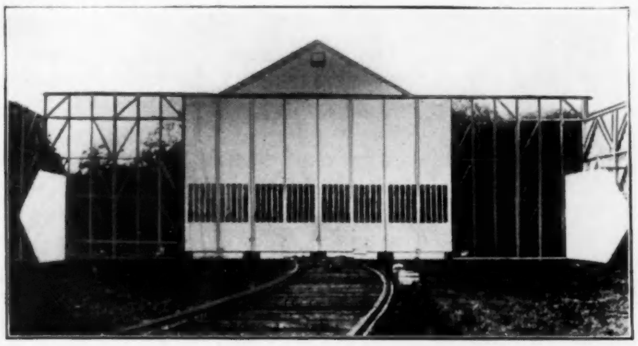
Steam Powerplant Used

Probably the most interesting part of the Maxim machine was the powerplant. The engines were of the horizontal type and compound. The cylinders were 5-in. and 8-in. bore, respectively, and 12-in. stroke. They were very light, the walls of the cylinders being only 3/64 in. thick. They were cut from a forging made by Whitworth, the material being known as "gunlock steel." Piston valves were used and the entire engine was built

*Consulting Engineer, Cincinnati.

up as much as possible of steel tubing. One peculiarity of the engine was the fact that the connecting rods were made with a double or universal joint, so any excessively hard strain would not bend the rods or cause undue side pressure on the pistons. The wisdom of this arrangement was shown by the fact that the engines went through a number of serious accidents without being injured.

The speed of the engines in operation was about 350 r.p.m. At that speed each developed approximately 160



TRACK LEADING FROM THE FACTORY

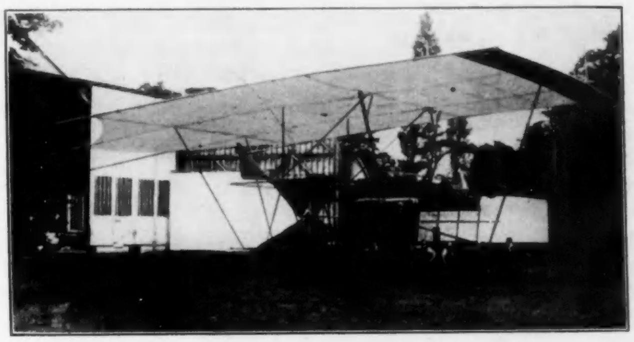
hp. The weight of each engine complete was 320 lb. Each engine was coupled directly to a propeller 17 ft. 10 in. diameter and 16 ft. pitch. The propellers were made of Norway pine built up from strips 1⅜ in. thick. After being cut to form and smoothed, the blades were covered with linen, glued on, and the linen was afterwards filled and the whole rubbed down to a smooth surface. Naturally, the screws were right and left and turned outward. That is, the uppermost tips of the blades ran towards the outside of the machine.

Between the engines was a differential gear arrangement to which a pointer was attached and so arranged that, when both engines were running at the same speed,

MAIN AND GUIDE TRACKS

the pointer would stand still, and if one engine were running faster than the other the pointer would revolve in the direction of the faster-running engine.

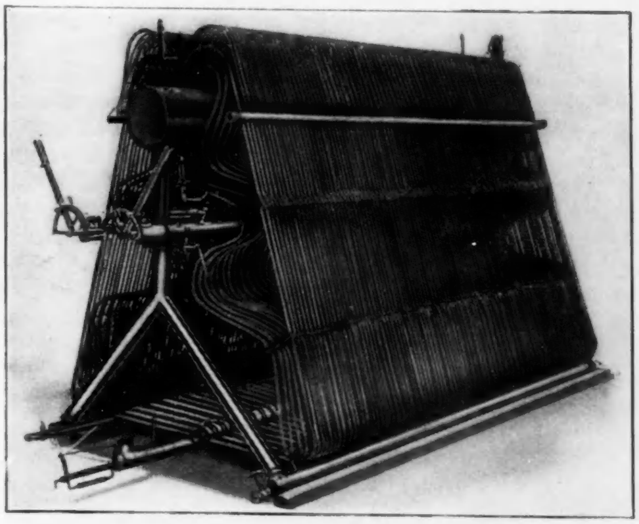
There were quite a number of good features on these engines, which space does not permit me to describe. One was the attachment of the boiler-feed pump to a tail-rod projecting from the low-pressure piston. The rod was so arranged that the stroke of the boiler-feed pump could be adjusted according to the requirements of the boiler. A similar arrangement was used for the fuel pump, and was controlled automatically.



FACTORY WITH FIRST MACHINE IN FOREGROUND

A very interesting feature of the power plant was the steam boiler. The boiler was of the Thornycroft type, composed of a large number of copper tubes ⅜ in. in diameter and 0.020 in. thick. The upper ends of these tubes were brazed to a steam drum consisting of a steel tube 8 in. in diameter. The lower ends of the copper tubes were brazed to a steel tube 2 in. in diameter.

The circulation of water in the boiler was accomplished by passing the feed water through an ejector in the down-take. The pressure of the feed water was held



STEAM BOILER OF THE MAXIM MACHINE

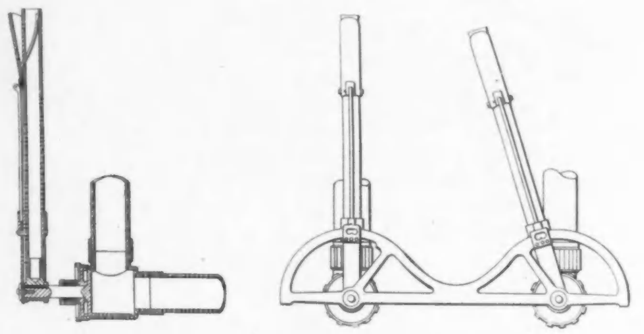
at 30 lb. above the pressure in the boiler and this insured very good circulation. Below the boiler was the fire-box, fitted with a branching burner supplied with gasoline vapor under 40-lb. pressure. As the vapor entered the burner it passed through a mixing valve very similar to that on a gas burner. There were 56 branches of the burner containing a total of 5940 tiny holes, and in operation these gave a solid mass of blue flame 22 in. high. This great heat and the construction of the boiler gave 100 lb. of steam, approximately one minute after starting up. The gasoline vapor for the burner was supplied from a small boiler in front of the main boiler. This was of the vertical tubular type heated from a burner using part of its own supply of fuel. The pressure of gasoline vapor in this small boiler was 40 lb. per sq. in.

As an instance of how light everything about this plant was made I might mention that a vacuum was unintentionally produced in this boiler by allowing it to cool when it was very nearly empty of liquid and filled with vapor. The atmospheric pressure caused the shell

to collapse, and the workmen had quite a task to straighten it out again.

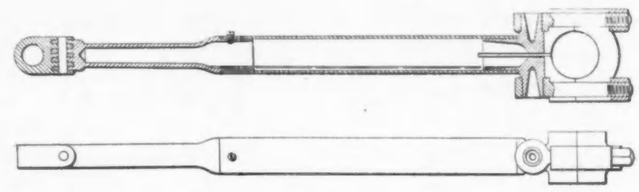
First Experiments

So much for the description of the machine. We will now take up the experiments of July 31, 1894. The factory was not large enough to house the machine with the side planes or wings in place. It was only wide enough to permit the entrance of the machine with the center section and the front elevators, and, in fact, the rear elevator had to be detached before they could close the front doors. The day in question the workmen began to assemble the machine as soon as they arrived, or at 7 o'clock. They first hoisted the rear elevator or rudder



Throttles for Operating the Two Engines

into place and then began to attach the wings. The machine was so large that it was necessary to do the work with the aid of ladders and scaffolding. The upper wings were attached, as will be seen in the photographs, to the center section or main plane. The lower wings were attached as closely to the bottom as possible, or so



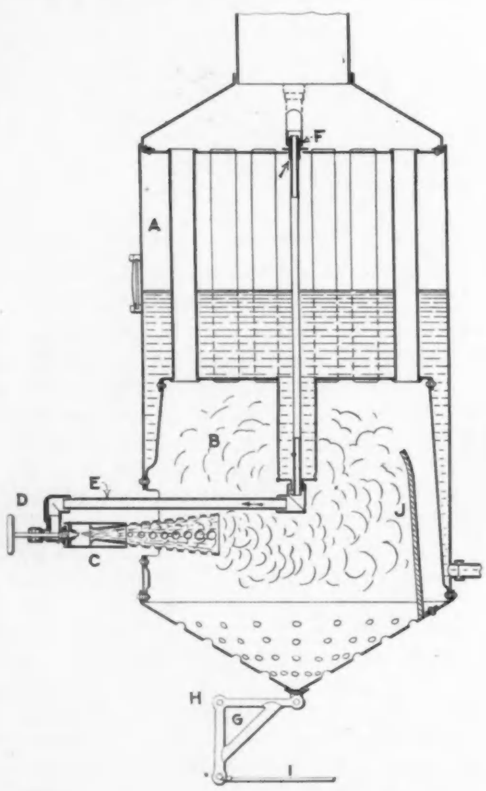
Engine Connecting-Rods

they would clear the rails of the experimental track about 2 ft.

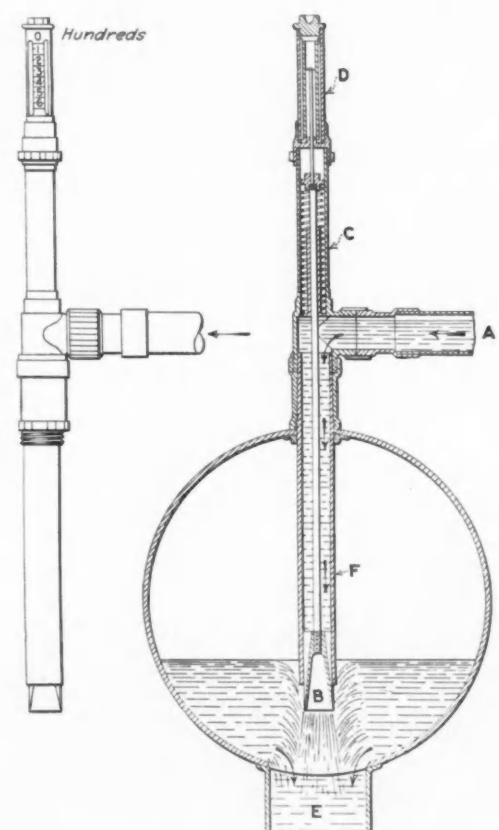
Guiding Tracks

Before describing the experiments it will be necessary to describe the experimental track. The machine rested on a truck with four iron-flanged wheels. This truck was purposely weighted to about 300 lb. and the machine proper rested on the truck supported by helical springs. As the machine lifted, the truck itself was held by its weight to the rails and the springs extended. The movement operated a pencil similar to that on a steam engine indicator, which made a trace on a paper attached to a small wooden drum. This drum was revolved slowly by the wheels as it ran along the track. This gave a record or graph of the lift of the machine at any point along the track. The gage of this center track was 8 ft.

Once, when Mr. Maxim was making his experiments, a sudden squall caught the machine on the side and overturned it. To prevent a repetition of this accident he fitted the machine with small brass-flanged wheels on outriggers, and these were run under overhanging wooden rails of 30 ft. gage. The arrangement was such



Sectional View of Small Boiler for Generating Gasoline Vapor

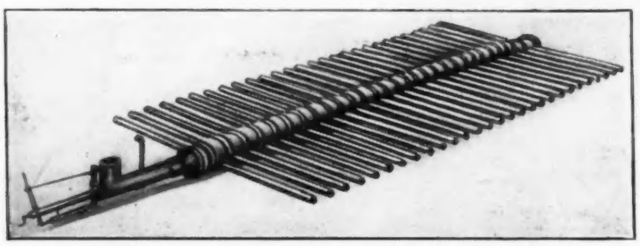


Feed Water Ejector

that when these outboard wheels on both sides were hard against the overhanging rail the machine would be lifting to its full capacity and carrying with it the truck lifted one inch off the center rails. The outer rails were made of Georgia pine 3 in. thick and 9 in. wide and were supported by posts driven into the ground and braced.

The length of the track from the factory was about 1800 ft., the length being limited by a grove which the owner of the estate would not permit to be touched. The section of the track immediately outside of the factory was curved, and this, together with an arrangement for stopping the machine before the end of the track was reached, limited the total running distance to about 1700 ft. On the front of the machine were two large, two-pronged forks and across the track at the opposite end from the factory were a series of ropes so arranged that they were caught by the forks and gradually stopped the machine before it reached the end of the track.

When the machine was ready for a trial, the burner under the gasoline boiler was lighted, and in about half an hour the pressure was sufficient to permit lighting

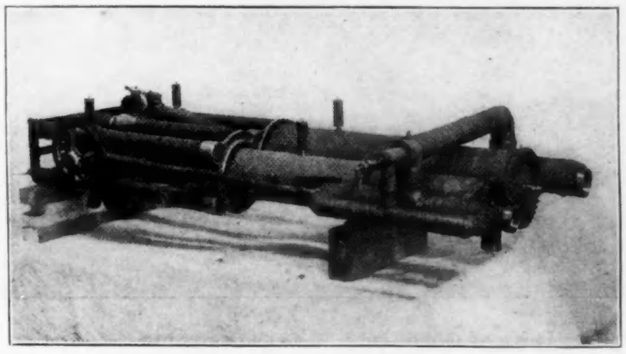


Showing the Gasoline Burner

the burner under the steam boiler which reached a working pressure of 300 lb. in a very few minutes. The machine was then tied up to a traction dynamometer, to which it was fastened by means of a slip toggle, which could be released, in an instant, by the jerk of a small rope. A wooden telegraph operated by the man at the dynamometer, and consisting of a pointer moving over a circular scale, showed the men on the machine the pull or, as the aviator calls it, the thrust. Mr. Maxim always manned the throttles and signalled to the men at the dynamometer to let go when he thought he had sufficient thrust.

When all was ready Mr. Maxim would take a place at the throttle just back of the boiler and start up the engines. The port engine was always started first, as it operated the gasoline pump. It was given steam slowly and, when it was at about half-speed, the starboard engine was started and brought to the same speed as its mate. The speed of both engines was then gradually increased until the desired thrust on the dynamometer was secured. Mr. Maxim would give one blast on a police whistle as a signal to get ready, and two blasts of the whistle was the signal for release. If the engines were at full-speed before release, the speed of the machine itself picked up rapidly and it was soon under full headway. About 1200 feet from the factory was a red signboard, standing beside the track. This was a signal to shut off the steam at this point. Five hundred feet further on were the ropes already referred to. The first two of these ropes were wound around capstans carrying paddles, forming wind brakes. A third rope was wound in and out among several posts set closely together and retarded the machine by friction against the posts. As a rule, the first two ropes had sufficient resistance to check the machine.

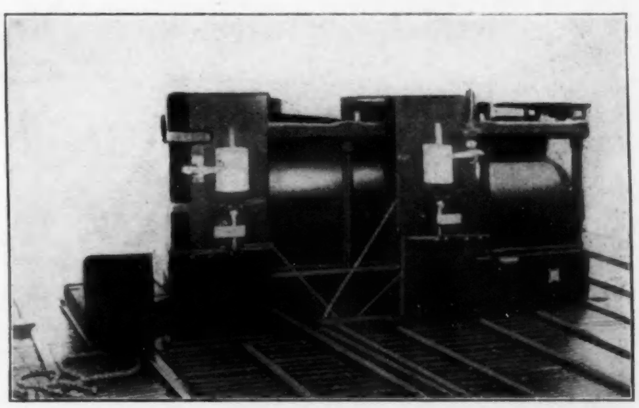
On the day in question the machine was ready for the first trial about 2 o'clock in the afternoon. Mr. Maxim took his place at the throttles and his foreman, Arthur Guthrie, and his assistant foreman, Thomas Jackson, took their accustomed places beside the water tank, as shown in one of the accompanying photographs. I was stationed 1000 ft. down the track from the factory, to watch the action of the planes, and the performance of



One of the Pair of Compound Steam Engines

the machine in general. The first run was made with a steam pressure of 150 lb. and a pull of 1100 lb. on the dynamometer. The speed, as recorded by a stop-watch, automatically operated by the machine itself over a distance of 1/20th of a mile was 27.2 m.p.h. The machine did not seem to make much of an effort to lift itself, but the run showed that all of the apparatus was working satisfactorily.

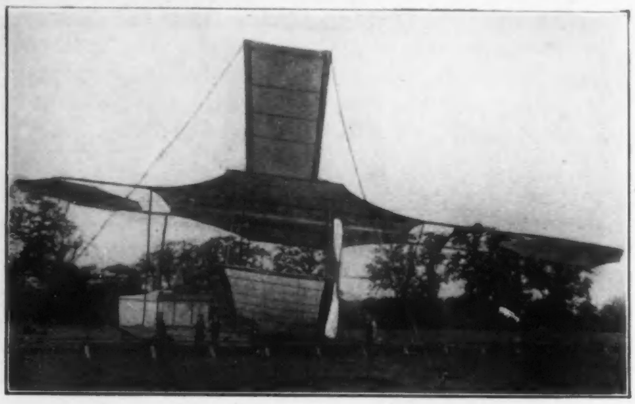
The second run was made with a steam pressure of 240 lb., the pressure being regulated by the size of the fire. The signal to start was given when the dynamometer showed a thrust of 1500 lb. From my post of observation, I could see that the upper surfaces of all of



Dynographs for Recording the Lift of the Machine

the planes were stretched tight and well rounded out. There was a light breeze blowing from the starboard side and that side was lifted from the track, but the port side did not lift. As it came down the track the forward rudder or "beak" was swaying like a locomotive coming around a curve. Unfortunately, the mechanism for operating the stop-watch failed to do its work and no record was made of the speed. It was estimated as 35 m.p.h.

I knew from the set look on Mr. Maxim's face, as we pushed the machine back to the starting point, that the next run would undoubtedly be a fast one. This belief was confirmed by the time elapsing from the starting of the engine until I heard the signal to let go. The big machine was scarcely under way, when I could see that

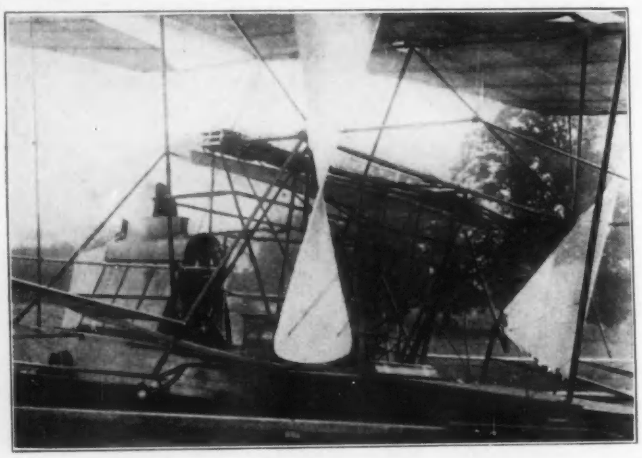


Port Side of Damaged Machine

the covering on the planes was as taut as a drum-head and they were tugging furiously at the many steel guy-wires. Something impelled me to back a step further away from the track, and it was a good thing I did so. When the machine was about 200 ft. from where I stood I heard the sound of breaking timber and snapping steel, and in the space of about a second the machine crashed through the wooden rail and came straight toward me. I bolted in the direction of a tree.

Ending of the Flight

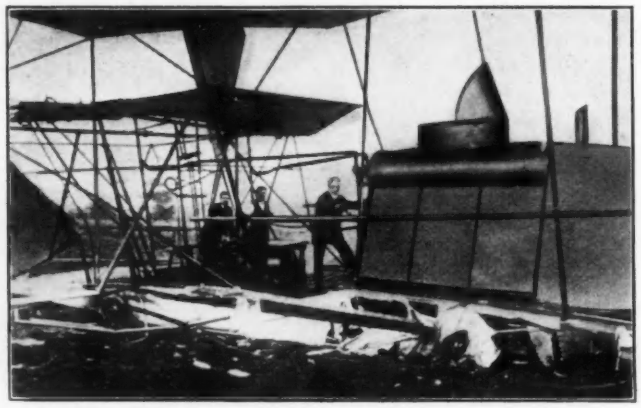
Looking back and over my shoulder I saw Guthrie and Jackson pitch headlong from the machine. Mr. Maxim was able to save himself by hanging to a rope stretched



Near View of Port Side

across the machine behind him. At first I was sure that at least one of the men was killed or seriously injured. Fortunately, with the exception of some ugly bruises, they were uninjured, and they were on their feet before I could reach the machine. I then learned that the thrust, at starting, had been 2100 lb. and that the steam pressure had been 310 lb. The stop-watch had disappeared and, when we found it, the hand was so badly twisted that no record was obtainable. Mr. Maxim judged that the speed was between 40 and 45 m.p.h. I am inclined to believe that the latter figure is probably the correct one. The condition of the machine, after the accident, can easily be seen from the accompanying photographs. The outrigging on the starboard side, and practically all of the starboard lower plane, was torn away. The starboard screw was more or less damaged on the tips, and the platform reminded one of a broken-down horse. One of the most singular things about this accident was a piece of broken upper rail that was thrust through the framework of the machine under the boiler, which gave it the appearance of a gigantic bird pinned to earth with an enormous arrow.

That the machine was actually in the air, supported entirely by its own planes, and for a considerable distance, was conclusively shown by a great many different

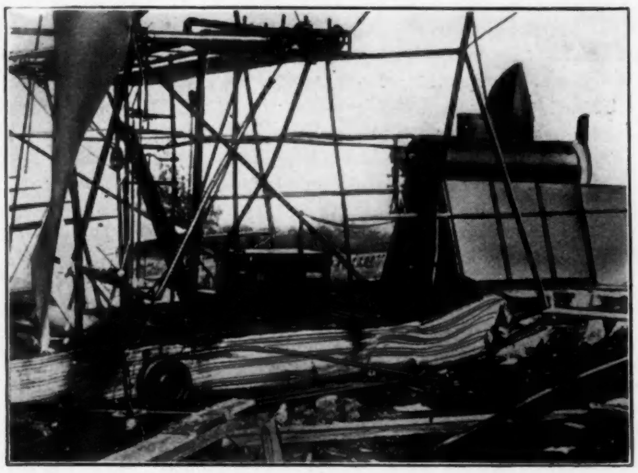


Starboard Side. Mr. Maxim and Assistants at their Stations

circumstances. It had been customary in former experiments to paint the outboard wheels, which ran under the wooden rail, so that, if they were against the rail for any distance, they would leave a record. This had been overlooked in the first two experiments, and I called this to Mr. Maxim's attention just before the third run, and he had them painted. In the third run this paint left its first record beneath the starboard rail 220 ft. from the start. At 349 ft. from the start both upper rails bore an unmistakable record from the paint. As, when both sets of outboard wheels were against the rails, the heavy truck was lifted 1 in. off the center rails, it was proved that the machine had not only lifted itself but the truck as well. It is possible that this record could have been made by one starboard and one port wheel instead of all four, but both Guthrie and Jackson were carefully observing these wheels and noted that all four were against the rails at one time. The paint showed a record for a distance of over 200 ft. At this point the lifting force was so much in excess of the weight of the machine that it buckled the outriggers holding the rear retaining wheels, and allowed the wheels to get free from the upper rails. The condition of the track after the run appeared to show that, after this framework had buckled up, the stern of the machine took on a vibrating motion, swinging from side to side and up and down. This threw the starboard rear retaining wheel into the posts of the upper rail because the flange of this wheel was so turned out of place as to miss the rail itself entirely.

The first marks of this wheel on the posts were about 200 ft. in advance of the point where the machine broke through the upper rail, or about 800 ft. from the factory. This collision with the posts had the same effect as steer-

ing a sled with one foot behind. It caused the front of the machine to dash through the rail on the same side. It was apparent from the marks of the paint, and other evidence, that the machine was supported entirely by the air, and clear of the middle rails, for a distance of 550 ft., and that for 200 ft. of this distance the after end was about 10 in. clear of the track. But the paint marks were not the only evidence that the machine had flown. The pencil carriers on the dynograph, which were held against the drums by springs similarly to the pencil on a steam engine indicator, had slipped entirely off the ends of the drums and were jammed underneath them. This proved that the tracing made by the extension of



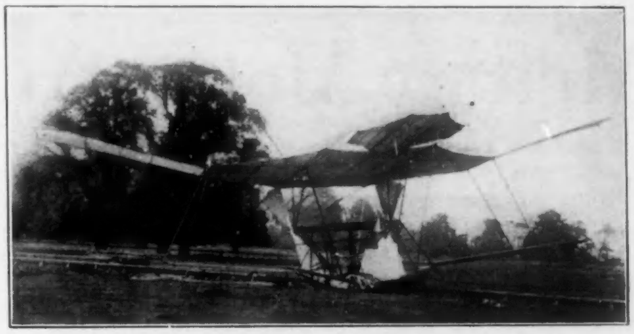
Near View of Starboard Side

the springs was at least beyond the limit of the drum face. In this connection it should be noted that the drums themselves were fastened to the airplane and the pencils were attached to the heavy truck. This dynograph was so arranged that the machine would be clear of the track before the pencil would leave the drum. The wheels of the heavy truck, which easily made a mark on the dense English turf, had sunk into the turf at the point where the machine stopped and they had left a track behind them for about two feet only. Had the machine run along the ground it is certain that a long track would have been made in the turf.

Weight Lifted

In spite of the damage to the machine, Mr. Maxim was very much elated by the results, as he believed that he had accomplished the first power flight in the history of man, this being the first time an airplane had lifted both itself and its operator clear of the

Front View of Machine, Port Side



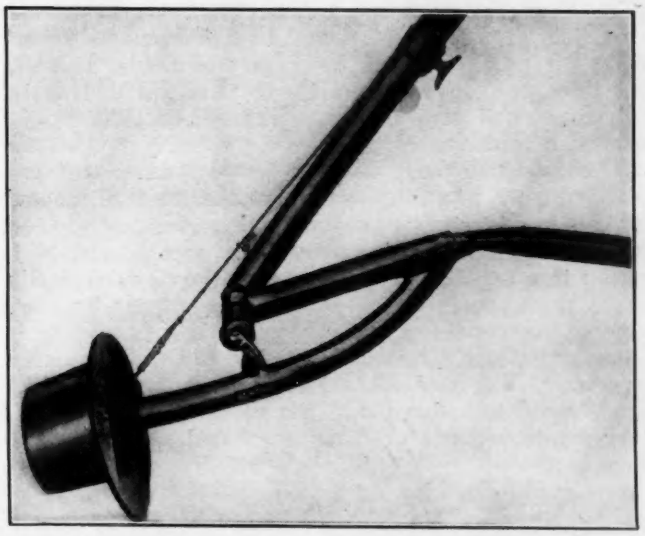
Front View of Machine, Starboard Side

ground. Outside of the weight of the machine itself, the following weights were lifted:

Water in tanks	350 lb.
Water in boiler	200 lb.
Gasoline in tank and boiler	200 lb.
Wheels and truck	500 lb.
Mr. Maxim	210 lb.
Guthrie and Jackson	280 lb.
Total	1740 lb.

The weight of the machine itself was 7800 lb., making a total lift of 9540 lb., plus the strain necessary to buckle the outriggers.

After the accident, the author took a number of photographs of the machine and an invitation was extended to the representatives of the engineering press of London to observe the machine before it was removed from the place of the accident. This invitation was gladly accepted, and the *Engineering News** and *Engineering*† of London both contain accounts of this flight. This test ended one series of experiments, as it proved that the machine was capable of lifting itself. It required about three months to make repairs after the accident, and this ended the experiments for that summer.



Buckled Outrigger

At last accounts the machine was in the Kensington Museum, London. One of the engines was lost by the sinking of the Titanic, as it was on its way to the first New York airplane show held in May, 1912.

*Issue of Aug. 30, 1894, page 174.
†Issue of Aug. 3, 1894, page 173. Also Aug. 10, 1894, page 196.

Military Motor Trucks in the Great War

BY COUNCILOR H. L. HORNING

THE Allies started the war with a small amount of information on motor transportation. Necessity made development rapid, but not until the winter of 1915-16 was a system evolved that could be counted on. The United States entered the war with the experience of the Allies at its disposal and with information of value gleaned from its own Mexican campaign. Upon this background of experience and information is based the design of our military truck and the plans for its use. These plans call for more trucks per million men than the combined requirements of Great Britain and France for armies comparable with ours. Comparatively speaking, there is only one place in the service where the use of horses prevents the American army from claiming complete motorization.

The organization necessary to keep the trucks in service exceeds in complexity that of a great motor-car plant. The base repair shops are the center of a small city, built in a convenient location and arranged with an eye to the purpose for which they are intended.

To appreciate what position motor transport occupies in the war, it must be realized that to supply our army with trucks alone will require double the number of ships we had in 1914. The Quartermaster Department, at the declaration of war, was purchasing the trucks for the army. So great was the demand of the various departments for trucks suiting their various needs, however, that they were given authority to purchase and design their own until such time as standardized models could be brought out.

Three methods were used in accomplishing this end. The Ordnance, the Engineers and the Medical Departments adopted certain commercial models, with such minor changes and improvements as would tend to fit them better for the particular service in view. The Signal Corps developed two creditable models for its needs by designing trucks to be built from high class parts by a number of truck makers. Finally the Quartermaster Department designed trucks from beginning to end, so completely standardized that the parts could be built in every available parts or truck plant and assembled anywhere.

During the year two four-wheel-drive vehicles have been standardized by the Ordnance Department and there have been developed five temporary standard models of the two-wheel-drive type, with three permanent models, completely new and standardized. No finer example of American enterprise and skill can be shown than the results attained by all the departments in their preparations for furnishing transportation for the army, and it is a credit to all that, notwithstanding the magnitude of the undertaking, motor truck deliveries are far in excess of shipping capacity.

In the year 1918 there must be delivered about a hundred thousand motor trucks for our army in France. These, with repair parts, will have a value close to $400,000,000. To appreciate what this means one has only to realize that the aggregate output of motor trucks in the whole country for the year 1917 was not over $270,000,000. To accomplish the task before us many passenger-car producers have given up regular production, and converted their plants to the making of trucks or truck parts.

The most difficult of all the methods of truck production was that used by the Quartermaster Department. But this method has achieved the most democratic result from the standpoint of industry and government, and the best from the military view; so it may be of interest to learn why it was undertaken and how accomplished.

ARGUMENT FOR STANDARD TRUCKS

The great value of a standard military truck lies in the matter of repairs and maintenance. In the army of one of the Allies there are so many models that if a truck of one department should break down before the repair station of another department it would be helpless. In the same army there are four standards of pneumatic tires and no end of sizes. The supply of tires for this army is so involved that it takes seven times the number to keep it going that would be necessary if the models were standardized or if the designs of trucks were coordinated. The problem of repair has been so severe that in some engagements the number of effective trucks has fallen as low as 25 per cent, while it is seldom possible to keep more than 60 per cent going at one time. Military efficiency has demanded great care in the interchangeability of guns and ammunition. But the war came so quickly that few countries were prepared with a truck having this cardinal military advantage. Many efforts have been made to solve the problem among the armies of the Allies, and already a degree of partial interchangeability has been secured.

The standard military truck of the American forces has been developed by the Quartermaster Department for the purpose of meeting all the requirements of military service. The army had the assistance of the Society of Automotive Engineers, now one of the great engineering bodies of the world, which assembled 50 experts from among its members. These were divided into eight groups, charged, respectively, with the development of engine, transmission and clutch, axles, chassis, electrical system, springs, radiator and cooling system, and miscellaneous parts. A chairman was designated for each group, and the fundamentals laid down in the general specifications issued by the Quartermaster Corps in the spring of 1917 were used throughout as a guide.

Each group laid out its unit to accomplish the best results possible from the specifications. So completely unselfish were the contributions of the members that there were incorporated valuable features which had been intended, by the several companies represented, for use as the basis of future sales. The idea on which the divisions worked was to produce the most reliable truck possible, and preference was accordingly to be given to all points in which greatest reliability was certain. Thus, while the truck was designed to give the best economy possible, it was deemed of greater importance that the engine be one that would run with certainty on the worst fuel possible. Above all it was considered of surpassing

From an article contributed by the chief of the Automotive Products Section, Council of National Defense, to the *Scientific American*.

importance to have a truck of great going ability. This meant a truck that could meet with ease heavy grades and bad going, and that would display conspicuous ability to get over soft ground.

Creating the Liberty Truck

After spending the month of August in discussion on design and the elements which enter into the making of a truck, the different groups started to lay out the Class B design on Sept. 1. This truck, while rated at three and a half tons, was to be built to take a load of five tons. A schedule committee was formed, consisting of the chairman of each of the parts groups and officers of the Quartermaster Corps. Starting Sept. 1 the drawings of all parts were to be done by the 10th, all the parts were to be completed by Oct. 1, and by Oct. 10 the two sample trucks were to be run on their own power.

The performance on this trying schedule was one of the finest mechanical achievements of the war. On Sept. 10 the drawings were practically completed and many of the dies and patterns begun. On Sept. 28 the first engines were running and the great majority of parts completed. The assemblers of the trucks received their parts about Oct. 1, and on the 8th the trucks were making short test runs. Two days later the trucks started for Washington—one from Lima, Ohio; the other from Rochester, N. Y. They came through without developing any mechanical defects, and one of them accomplished its journey without the use of a wrench. On Oct. 19 they were formally delivered and accepted by the Secretary of War in a very impressive ceremony. They were afterward presented for inspection by President Wilson, who expressed great admiration for the speed of delivery and the results.

Many interesting obstacles were overcome in turning out these standard trucks. The pattern for the crankcase was produced in seven days, although a job which usually takes from three weeks to a month. The cylinder pattern, the making of which ordinarily requires over three weeks, was likewise completed in five days. The crankshaft dies were sunk in seven days, although this operation usually requires three weeks. During the time these jobs were under way there was such congestion in the express service that many parts were delayed or lost in transit. One company's purchasing agent carried crankshafts in his Pullman car so as to be certain of delivery.

The schedule committee laid down the month of January as the time when production must commence. On Jan. 10, at the annual banquet of the Society of Automotive Engineers, word was received that the first five trucks were that day completed. By May 1 the trucks will be in production of over a thousand per month, and this figure will rapidly increase until a rate is attained of over 60,000 per year.

Since the delivery of the first samples of the Class B truck, Class A 1½-ton and Class AA ¾-ton trucks have been designed, completed and delivered in Washington. These trucks and many of the parts therefor were completed in even shorter time than that taken by the Class B truck. The smaller trucks follow closely the design of the larger model. These trucks can be considered the last word in design and efficiency for military purposes. As an illustration of what has been attained, the engines developed over 10 per cent more power at normal speeds than present models, while they have 10 per cent greater economy.

The army had the assistance of the Automotive Products Section of the War Industries Board. Through the agency of this board, the resources of the industry were brought to the aid of the Government with the utmost rapidity. After the design of the Class B truck was well under way, the Military Truck Committee was formed as part of the Automotive Products Section. This committee laid the foundation of the section which has charge of the production of military trucks, passenger cars and motorcycles, under the Quartermaster Department.

Few contributions to the art of war ever attained importance in the pursuits of peace. It can, however, be said that these trucks have already had a profound effect on the design and requirements of commercial trucks, and that they are considered by authorities to be notable contributions to the art of motor transportation. Out of the discussion as to how to test this engine and this truck came the system of driving the trucks to the seacoast, thus training the crews, testing the trucks and relieving the freight congestion, all at one time. Inseparable from this activity is the great contribution that the motor truck is making toward the solution of our railroad problem in this country, by means of highway transportation. Military roads will soon be a fact; motor trucks will be our main defense.

OPPORTUNITIES IN THE TANK CORPS

MEMBERS of the Society are offered an excellent opportunity to render the country a signal war-time service.

The newly organized Tank Corps of the National Army is recruiting men for service with the American tanks to be sent abroad. Engineers are particularly well fitted for this branch, and they are urged not only to enlist themselves, with the idea of working up to commissions, but to influence qualified young men of their acquaintance to enlist.

The Tank Corps is one of the few branches of the army open to men of draft age. The age limits are eighteen to forty-five.

Intensive recruiting has been started, and applicants should apply in person or by letter or telegraph to the nearest Army Recruiting Headquarters, where enlistments for service with the tanks are being accepted. These offices are at New York, Boston, Cleveland, Detroit, Birmingham, Ala., Kansas City, and Philadelphia.

This is going to be one of the most spectacular organizations in the army, and only men of the highest type are wanted. Mechanical knowledge is of advantage, but not absolutely necessary, as there are different kinds of work to be done.

Members are urged to cooperate to the limit in this matter.

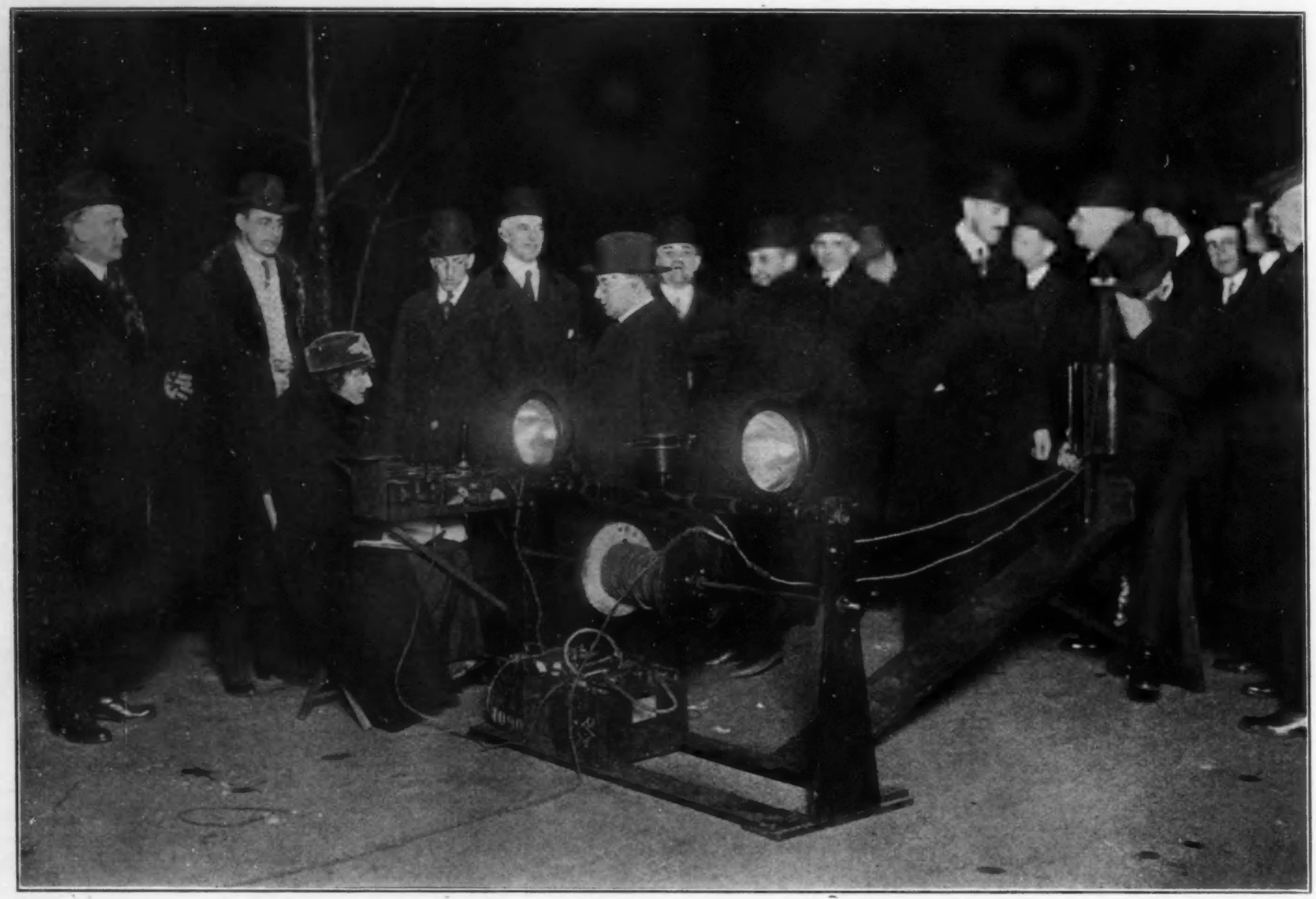


Fig. 1—Photograph of Apparatus Used for Test and of Observers

Automobile Head-Lamp Illumination

HOW much light is necessary to reveal a man in dark clothes 250 ft. in front of a car and how much light can the driver tolerate in his eyes without objectionable and unsafe glare for passing?

The Lighting Division of the Standards Committee of the Society has had this question under consideration for the past few months, and with the cooperation of the Automobile Headlight Committee of the Illuminating Engineering Society and the Electrical Testing Laboratories, arrangements were made for a road test with controllable head-lamps and photometric apparatus to record the actual intensity of light in foot-candles.*

The tests were held on March 5, on a short stretch of asphalt road between Pelham Parkway and Morris Park station of the New York, Westchester and Boston Railroad. Invitations were extended to many of the Eastern State officials, as the subject was of much interest to those interested in forming the automobile head-lamp illumination laws.

The results of these tests were discussed at a meeting held April 11 at the Electrical Testing Laboratories, New York. This was a joint meeting of the New York Section of the Illuminating Engineering Society and the Metropolitan Section of the S. A. E. A full account of it will appear in the May issue of THE JOURNAL.

The object of the head-lamp on an automobile is to give sufficient illumination ahead of the car to make night driving comfortable and safe. If in the attainment of this object an illumination is produced that blinds the driver of an approaching car, an unsafe condition is introduced, besides spoiling much of the pleasure of night driving.

The object of the preliminary work is to determine two points. The first point to be determined is the minimum amount of illumination necessary, for the safety of both driver and pedestrian, to reveal from the driver's seat a man in dark clothes in the road 150 and 250 ft. in front of the car. More light may be desired for fast driving or for illuminating the side of the road. There should be no objection to more light than this, provided it does not produce objectionable glare in the eyes of the driver of an approaching car.

The second point to be determined is the intensity of glare a driver can tolerate in his eyes and still see the section of road beside the approaching car and over which he must pass. This is more difficult to determine than the visibility of an object, as the intensity of light from the driver's car influences the amount of glare the driver can stand. A reasonable amount of light from the car should be projected ahead on the road at the time of

*A foot-candle, the unit of illumination, is the amount of light falling on an object 1 ft. away from a light source of 1 candle-power and varies inversely as the square of the distance. For example: A 24-cp. lamp placed 3 ft. from an object will give an illumination on an object of 2.66 foot-candles. This is considered good illumination for reading.

making the glare observation. This point was carefully considered and it was decided that the most acceptable and fairest condition of making the glare test was to have the light of the operator's car set at the intensity which he personally considered necessary to reveal a moving object 250 ft. in front of the car.

In order that this factor should be available for the glare test the observer first made a visibility test for 150 and 250 ft. respectively. With the illumination set at this intensity, the opposing lights were turned on and the glare observation made.

A description of the operation and care with which the photometric readings were taken is of much interest, Fig. 1 shows the apparatus and Fig. 2 the relative location of the automobile head-lamps. The head-lamps were of the true parabolic type with clear electric incandescent bulbs and clear front glasses. They were mounted in the same relative position as on a car, but on rigid stands so there would be no variation of the light beam during observation. If the lamps were attached to the cars the beam of light would vary for each observer due to spring deflection for different weights and loading of the cars. It was also necessary to chart the field of light at the 150-ft. and 250-ft. distances in order to obtain consistent readings, as the beam of light from an ordinary parabolic head-lamp reflector is of uneven intensity. The average of the effective part of the lighted area was taken, therefore, as the effective illumination.

As these fields were charted the current readings on the electric incandescent bulbs in the head-lamps were taken so that when the final observations were made by the driver, the current readings would indicate a direct relation to the number of foot-candles, or light intensity, falling on the men at the 150 and 250-ft. distances.

The small area covered by the eyes of the observer during the glare test was also charted, but for accuracy it was necessary that the eyes of each observer be in very nearly the same position so as to avoid the unevenness of the light beam. While practically this variation of the light beam cannot be detected by the eyes, the instruments are so sensitive that they do detect it and must be taken into consideration in order to place the correct value on the reading of the observer.

Forty-nine observations were taken, as shown in Table I. The observers are designated by numbers, but their names are in the Committee's records.

Table I—Automobile Head-Lamp Illumination Test Observations

No.	Driving Experience. Approx. Night Mileage†	Visibility 150 Ft. (45.7M.) Cp.	Visibility 150 Ft. (45.7M.) Ft. C.‡	Visibility 250 Ft. (76.1 M.) Cp.	Visibility 250 Ft. (76.1 M.) Ft. C.‡	Glare 100 Ft. (30.5 M.)§ Cp.	Glare 100 Ft. (30.5 M.)§ Ft. C.‡
1*	1,000	2,100	0.094	9,500	0.152	....	....
2*	0	1.300	0.058	2.500	0 040	....	....
3*	4,000	2,500	0.111	5,800	0.093	....	....
4	5,000	1,300	0.058	6,500	0.104	170	0.017
5*	4,000	3,500	0.155	3,500	0.056	105	0.010
6	350	4,800	0.214	9.000	0.144	615	0.061
7	0	10,000	0.445	18,300	0.293	105	0.011
8	5,000	4,000	0.178	9.000	0.144	665	0.067
9	0	10,000	0.445	17,800	0.285	90	0.009
10	—	1,500	0.067	2,200	0.035	85	0.008
11	2,000	2,150	0.095	11,500	0.184	235	0.023
12*	1,000	1,900	0.084	3,200	0.051	90	0.009
15	0	2,500	0.111	7,800	0.125	325	0.032
16	—	4,000	0.178	6,300	0.101	425	0.042
17	2,000	4,000	0.178	6,300	0.101	105	0.010
18*	1,000	4,800	0.214	10,500	0.168	170	0.017
20	6,000	1,900	0.084	3,300	0.053	125	0.012
21	—	2,200	0.098	6,300	0.101	170	0.017
22	5,000	1,600	0.071	2,800	0.045	105	0.010
23	7,000	2,800	0.124	8,400	0.134	235	0.023
24	300	1,150	0.051	2,000	0.032	125	0.012
25	2,000	2,500	0.111	1,300	0.021	125	0.012
26*	400	2,100	0.093	9,400	0.150	325	0.032
27	0	2,500	0.111	4,000	0.064	80	0.008
29	400	2,100	0.093	3.500	0.056	100	0.010
30*	500	7,400	0.330	12,100	0.193	320	0.032
31*	1,000	6,300	0.280	11.000	0.176	520	0.052
32	1,000	2,500	0.110	6,300	0.101	125	0.012
33	0	3,200	0.142	6,800	0.109	105	0.010
34	4.000	1,800	0.080	3,300	0.053	520	0.052
35	700	4,300	0.191	10,000	0.160	145	0.014
36	2,500	5,200	0.231	12,100	0.193	850	0.085
37	1,000	1,500	0.067	6,300	0.101	170	0.017
38	4,000	3,200	0.142	9,000	0.144	170	0.017
39*	5,000	2,800	0.124	4,000	0.064	170	0.017
40	3,000	1,100	0.049	1,300	0.021	170	0.017
41	500	2,500	0.111	4,300	0.069	100	0.010
42*	—	1,800	0.080	2,500	0.040	125	0.012
43	1,750	2,800	0.124	7,800	0.125	200	0.020
44	1,500	6,300	0.280	13,500	0.216	520	0.052
45	500	1,000	0.046	1,800	0.029	325	0.032
47*	500	9,400	0.418	14,700	0.235	235	0.023
48	0	1,650	0.073	9,400	0.150	90	0.009
49	500	1,500	0.067	9.400	0.150	125	0.012
50	1,000	1,100	0.049	3,200	0.051	520	0.052
51	0	1,800	0.080	5,600	0.090	520	0.052
118*	0	3,200	0.142	9,400	0.150	170	0.017
120	500	1,800	0.080	5,200	0.083	145	0.014
121	0	——	——	3,200	0.051	90	0.009
Average observations		3,200	0.142	6,980	0.112	239	0.024
Range in cp.		1,000–10,000		1,300–18,300		80–850	
Range in foot-candles		0.0445–0.445		0.021–0.293		0.008–0.085	
Median values		2,500–0.11		6,300–0.10		170–0.017	

†To convert to kilometers multiply by 1.61.
‡To convert to milliphots multiply by 1.0764.

*The following remarks were submitted by the observers indicated:

(1) Seemed that I took lower limit for visibility than I should like in order to have complete feeling of security. I could just see the men and might not have seen them had they been stationary. My glare value was higher than best comfort considerations would require. It was as much as I thought I could stand.

(2) Visibility test: Intensity sufficiently high to leave no doubt that man is there. Glare: Man distinctly visible when in center of beam. Face always visible even at higher intensity of glare lamps. If glare lamps are run too high at first a lower glare candlepower will be obtained, as the eyes require a little time to recover.

(3) For 150 ft. (45.7 m.) distance, slightly higher illumination of object is necessary than for 250 ft. (76.1 m.) on account of less distance. Pickup in each case was on man as a whole, not on fare or collar. For glare test, it was impossible to get low enough value of current and be able to see man at 250 ft. (76.1 m.); at 150 ft. (45.7 m.), his face and collar alone were visible. The intensities at 150 ft. (45.7 m.) and 250 ft. (76.1 m.) were what I considered a minimum for driving at 20 miles (32.6 km.) per hour. High intensities would be necessary for higher speed. If head-lamp near to were of higher intensity, possibly the glaring lamps would be all right.

(5) Man at 150 ft. (45.7 m.) was plainly visible with lamp on. He was at the other side of the lamp. Road was plainly visible.

(12) Light enough to distinguish full object on turns.

(18) Most of my work has been as observer on front seats. I think due allowance should be made for the fact that many times I do not concentrate vision to the right of the approaching car.

(26) Visibility at 150 and 250 ft. (45.7 and 76.1 m.): Saw man's face plainly, rest of body rather indefinite. Glare: Man at 150 ft. (45.7 m.) still visible, but judged glare which would not be annoying largely by appearance of road curb, etc.

(30) Observations 1 and 2: Light adjusted so that the persons were entirely visible at all times. I consider it the safe criterion. Observation 3: Maximum candlepower for safety in passing, but not necessarily the maximum for seeing objects, at 150 and 250 ft. (45.7 and 76.1 m.)

(31) Could stand more glare.

(39) Observation at 150 ft. (45.7 m.) a little strong.

(42) At glare limit, man crossing at 150 ft. (45.7 m.) is invisible.

(47) The moving man had a white face and shirt; and the white surface was visible farther than his dark clothes.

(118) Glare very uncertain judged by visibility of man at 250 ft. (76.1 m.) in middle of right-hand driveway.

§Glare taken with visibility intensity for 250 ft. (76.1 m.).

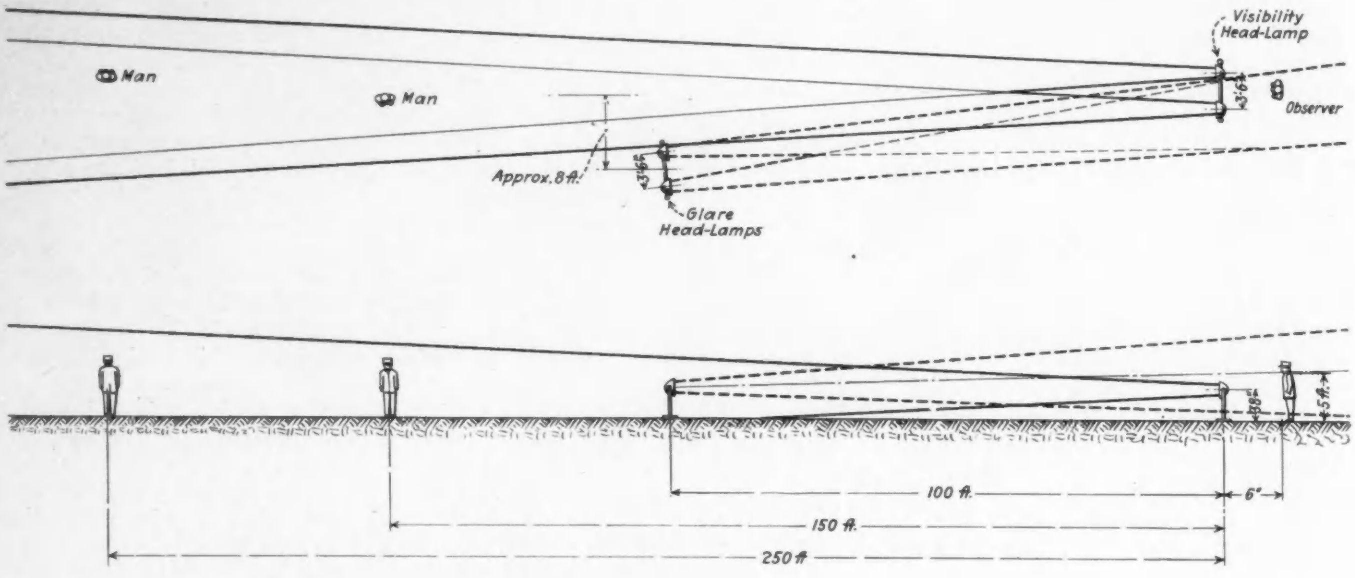
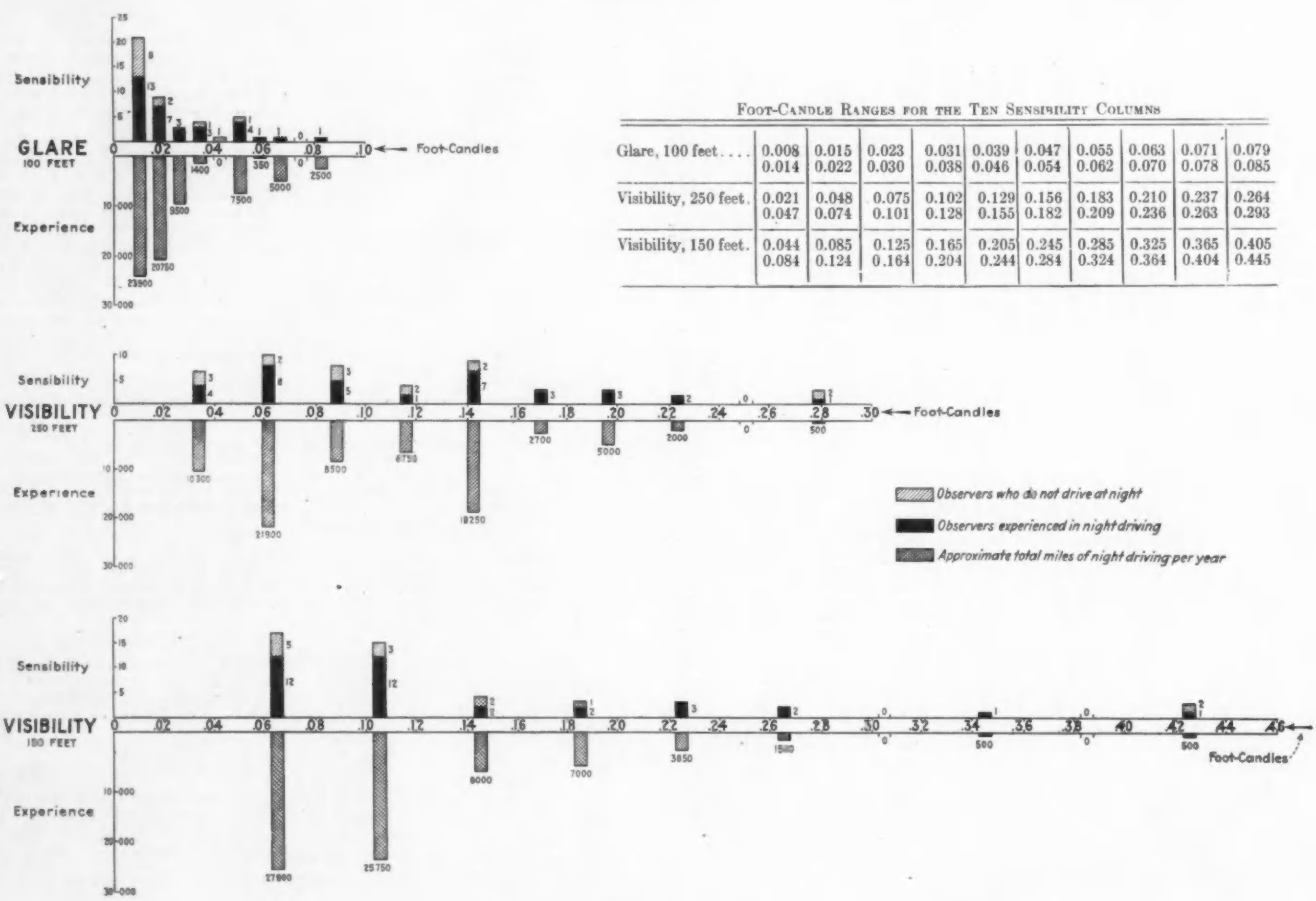


FIG. 2—DIAGRAMMATICAL ARRANGEMENT OF APPARATUS



FOOT-CANDLE RANGES FOR THE TEN SENSIBILITY COLUMNS

Glare, 100 feet....	0.008 0.014	0.015 0.022	0.023 0.030	0.031 0.038	0.039 0.046	0.047 0.054	0.055 0.062	0.063 0.070	0.071 0.078	0.079 0.085
Visibility, 250 feet.	0.021 0.047	0.048 0.074	0.075 0.101	0.102 0.128	0.129 0.155	0.156 0.182	0.183 0.209	0.210 0.236	0.237 0.263	0.264 0.293
Visibility, 150 feet.	0.044 0.084	0.085 0.124	0.125 0.164	0.165 0.204	0.205 0.244	0.245 0.284	0.285 0.324	0.325 0.364	0.365 0.404	0.405 0.445

FIG. 3—CHART SHOWING ANALYSIS OF ILLUMINATION AND GLARE OBSERVATIONS

Analyzing the observations in Table I to obtain an expression as to the popularity of various light intensities, the chart, Fig. 3, gives a good graphic illustration of the glare at 100 ft. and visibility at the 150 and 250-ft. distances. As a car approaches, the glare becomes more and more annoying up to the point where the light intensity begins to diminish by reason of the angle introduced in passing. It was considered by the Committee that this maximum distance was approximately 100 ft. in front of the car.

For simplification of expression, each series of foot-candle readings was divided into ten groups, as shown by the vertical columns. The number of drivers and their light sensibility (foot-candles) is shown by the upper columns and the corresponding experience of these drivers in miles of night driving per year in the lower columns. This shows the opinion of the observer as to the glare and visibility. The chart also reflects, against the driver's experience, his judgment of glare, as it is obvious that a man having no experience in night driving is less qualified to state what is objectionable glare than the man who has had considerable experience in night driving. The scale is the same for all three charts so they may be comprehensively studied and compared.

It is appreciated that this work and the results are only a start in analyzing head-lamp illumination, but it brings out clearly for the first time the actual numerical values for visibility and glare. How these values are to be met and the relative comfort and safety derived from the various lens designs aiming at these numerical values when driving, approaching and passing are subjects worthy of further careful consideration.

Fig. 4—Photograph of Road Showing Illumination

ANNUAL GAS ENGINE ASSOCIATION CONVENTION

THE eleventh annual meeting of the National Gas Engine Association has been announced for June 3 and 4, to be held at the Sherman Hotel, Chicago. Secretary H. R. Brate announces that the program has been about completed, and that it will cover business of particular interest to the industry at this time.

On Monday forenoon there will be a joint meeting of the association and members of a committee from the National Implement & Vehicle Dealers Association, for the purpose of discussing the matter of repair parts for gasoline engines. The cost and the prices to be charged for such parts constituted one of the matters that came up for discussion at the last annual N. G. E. A. convention. Repair parts and their costs are subjects about which the dealers' associations throughout the country have thought a good deal. Most dealers and dealer association officers have very pronounced views, and so have the manufacturers. It has been the experience of many manufacturers that when a meeting of this kind was held manufacturer and dealer could arrive at a basis of common understanding, and it is expected that such will be the case at this convention of the gas-engine trade.

In the afternoon the subjects will be as follows:

The Iron and Steel Situation, suggestions, prophecies, etc.

Government Requirements on Gas Engines and the Method of Handling Those Matters at Washington.

The Labor Situation.

The Fuel Problem. This will be handled by a representative of the Federal Fuel Administration.

On Tuesday forenoon the following papers will be read:

What Is the Future of the Farm Gas Engine Business, in View of the Tractor Eliminating the Portable and Larger Sizes?

Sizes to Manufacture from the Manufacturing and Sales Standpoints.

The Present Condition and Future of the Gas Engine Export Trade.

On Tuesday afternoon there will be a technical session in connection with the Mid-West Section of the Society of Automotive Engineers, at which several papers of a technical nature will be presented.

In the evening a dinner will be held, also under the auspices of the Mid-West Section, followed by a "War Service" session, the time of which will be devoted largely to patriotic matters.

Current Standardization Work

IT has been decided to hold a meeting of the Standards Committee at the Dayton (Ohio) Engineers' Club on Sunday, June 16, the day preceding the first session of the Semi-Annual Meeting.

A joint meeting of the Marine Division of the S. A. E. and the members of the subcommittee appointed from the National Association of Engine and Boat Manufacturers was held in New York City at S. A. E. headquarters on Saturday morning, April 20.

The following subjects were considered at this meeting:

Standardized motor lifeboat units.
Height of shaft.
Horsepower carrying capacity of shaft couplings.
Engine and reverse-gear foundations.
Engine bed timbers.
Marine hardware.

A meeting of the Tire and Rim Division was held on April 13 at the Statler Hotel, Cleveland. Among the important subjects brought up for action were: (1) Simplification of pneumatic tire sizes, (2) solid tire section contours, (3) solid tire rim section contours, (4) valve holes for automobile and motorcycle pneumatic tire rims. J. E. Hale submitted a report in which he discussed the desirability of limiting the range of truck models according to the pay load capacity and proposed an exclusive tire size for each model in order to simplify the tire size problem. He showed that at present thirteen different capacity models are offered to the public, some of which could be eliminated in favor of the more popular sizes. A full account of the meeting will appear later.

A meeting of the Electrical Equipment Division was held at the Kresge Building, Detroit, on April 16, and will be reported in a later issue of THE JOURNAL.

ENGINE DIVISION PROGRESS

A MEETING of the Engine Division was held at the Kresge Building, Detroit, on the morning of April 15. A report of the meeting will appear later.

Canadian Automobile License Rating

A letter from H. W. Perry of the National Automobile Chamber of Commerce, dated March 25, has been referred to the Engine Division. In this letter Mr. Perry quotes a letter written by George A. McNamee, secretary-treasurer of the Automobile Club of Canada, to Elmer Thompson, general manager of the Automobile Club of America, stating that the Canadian Government has recently adopted a new horsepower rating formula, under which automobiles are to be licensed. The formula is as follows:

$$\frac{D^2 \times N \times C}{10}$$

in which

D = cylinder bore in inches.
N = number of cylinders.
C = piston stroke in inches.

The registration rate is given at 70c. per horsepower.

In regard to this, Mr. McNamee writes, "Our Government has changed the formula with a view of making some consideration for the owners of small cars and applying the loss of revenue thereby to the larger cars. While we did not agree with it we were able to effect a change in the formula which gave, in our opinion, a more reasonable formula than the one proposed by the Government."

Comments on the suitability of this formula for American practice would be of service to the division.

TRACTOR DIVISION MEETING

ON MARCH 9 a meeting of the Tractor Division was held at the New Morrison Hotel, Chicago. The meeting was attended by Dent Parrett (chairman), E. R. Greer, Henry Farrington, Wayne H. Worthington, F. N. G. Kranich, Frank Squire and Standards Manager M. W. Hanks.

Complete Tractor Specifications—In view of the annoyance to tractor manufacturers in filling out technical blanks sent to them by various publications and advertising agencies, it was moved, seconded and carried that the division arrange a standard complete tractor specification form to be distributed to tractor manufacturers, publications and advertising agencies with the request to use this form when such information is desired. One filling out of this form will provide for answering all inquiries and simplify the correspondence immensely.

A first draft of complete tractor specification was submitted by Chairman Parrett and it was decided that the specification be adopted subject to such revision as may be received by submitting the specification to letter ballot.

Connecting-Rod Bearings.—The consensus of opinion was to the effect that this subject be dropped until such time as the condition of the industry warrants further consideration.

Power-Belt Widths.—It was approved that the subject of pulley widths as covered at the Feb. 1 meeting (see page 181, February JOURNAL) be presented to the Standards Committee as an S. A. E. recommended practice.

Steel and Shafting Sizes.—The division recommends the following S. A. E. steels for tractor construction:

S. A. E. steel No. 1020 for all ordinary hot and cold-rolled shafting, gear blanks and shapes. Also for cold-rolled bars for general use.

S. A. E. steel No. 1045 for all hot and cold-rolled special shafting where hard surfaces are needed.

W. J. McVicker, chairman of the subcommittee on shaftings, reported that his committee had canvassed the tractor and transmission manufacturers for data on the clearances allowed on spline shafting to be used in connection with the six-spline broach, which is to slide when not under load, and which was suggested by

the Tractor Division of the Standards Committee as standard for tractor service.

The result of this canvass showed that this or any S. A. E. spline was used in but few instances, the average practice being to give the small diameter as nominal diameter, allowing the larger diameter to come in odd sizes, that is, not in sixteenths.

From information received, this committee has prepared the accompanying illustration and table showing the sizes of shafting, with limits of each, for fits on large diameter, small diameter, and sides of spline.

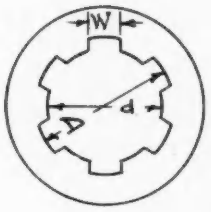
It has been considered best to give more allowance on shafts 2 in. and over, and the following table gives the allowance made. In each case the allowance given is taken from the maximum size of the broached hole.

The committee suggests that the broach sizes be standardized for 2⅜, 2⅝, 2¾, 2⅞, 3¼ and 3½-in. shaft sizes.

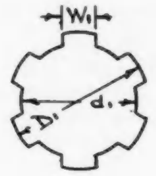
The committee suggests that the Standards Committee make a detailed study of this table, and also that it be submitted to the tractor and transmission manufacturers for their approval or correction.

Screws and Bolts.—The recommendation made at the Feb. 1 meeting (see page 181, February JOURNAL) was ratified and approved for presentation to the Standards Committee.

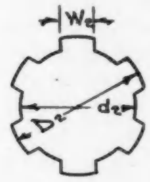
Carbureter Flange.—Attention was called to the fact that some of the carbureter companies were making 1⅜-in. carbureters (not an S. A. E. standard) because certain engines were found to perform better with this size



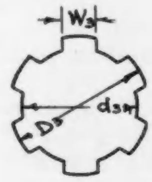
6-B
S. A. E. STANDARD BROACH



6-BA
SHAFT TO FIT ON LARGE DIA.



6-BB
SHAFT TO FIT ON SMALL DIA.



6-BC
SHAFT TO FIT ON SIDE OF SPLINE

DIMENSIONS IN INCHES OF SIX-SPLINE BROACH AND SHAFTING FOR HARD GEAR AND SOFT SHAFT
(To Slide When Not Under Load)

Nom. Dia., In.	D	d	W	D_1	d_1	W_1	D_2	d_2	W_2	D_3	d_3	W_3
¾	0.750	0.638	0.188	0.748	0.628	0.183	0.740	0.636	0.183	0.740	0.628	0.186
	0.749	0.637	0.187	0.747	0.626	0.181	0.738	0.635	0.181	0.738	0.626	0.185
⅞	0.875	0.744	0.219	0.873	0.734	0.214	0.865	0.742	0.214	0.865	0.734	0.217
	0.874	0.743	0.218	0.872	0.732	0.212	0.863	0.741	0.212	0.863	0.732	0.216
1	1.000	0.850	0.250	0.998	0.840	0.245	0.990	0.848	0.245	0.990	0.840	0.248
	0.999	0.849	0.249	0.997	0.838	0.243	0.988	0.847	0.243	0.988	0.838	0.247
1⅛	1.125	0.956	0.281	1.123	0.946	0.276	1.115	0.954	0.286	1.115	0.946	0.279
	1.124	0.955	0.280	1.122	0.944	0.274	1.113	0.953	0.284	1.113	0.944	0.278
1¼	1.250	1.063	0.313	1.248	1.053	0.308	1.240	1.061	0.308	1.240	1.053	0.311
	1.249	1.062	0.312	1.247	1.051	0.306	1.238	1.060	0.306	1.238	1.051	0.310
1⅜	1.375	1.169	0.344	1.373	1.159	0.339	1.365	1.167	0.339	1.365	1.159	0.342
	1.374	1.168	0.343	1.372	1.157	0.337	1.363	1.166	0.337	1.363	1.157	0.341
1½	1.500	1.275	0.375	1.498	1.265	0.370	1.490	1.273	0.370	1.490	1.265	0.373
	1.499	1.274	0.374	1.497	1.263	0.368	1.488	1.272	0.368	1.488	1.263	0.372
1⅝	1.625	1.381	0.406	1.623	1.371	0.401	1.615	1.379	0.401	1.615	1.371	0.404
	1.624	1.380	0.405	1.622	1.369	0.339	1.613	1.378	0.399	1.613	1.369	0.403
1¾	1.750	1.488	0.438	1.748	1.478	0.433	1.740	1.486	0.433	1.740	1.478	0.436
	1.749	1.487	0.437	1.747	1.476	0.431	1.738	1.485	0.431	1.738	1.476	0.435
2	2.000	1.700	0.500	1.997	1.690	0.495	1.990	1.696	0.495	1.990	1.690	0.497
	1.998	1.698	0.498	1.996	1.688	0.493	1.988	1.695	0.493	1.988	1.688	0.496
2¼	2.250	1.913	0.563	2.247	1.903	0.558	2.240	1.910	0.558	2.240	1.903	0.560
	2.248	1.912	0.561	2.246	1.901	0.558	2.238	1.909	0.556	2.238	1.901	0.559
2⅜	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2½	2.500	2.125	0.625	2.497	2.115	0.620	2.490	2.121	0.620	2.490	2.215	0.622
	2.498	2.123	0.623	2.496	2.113	0.618	2.488	2.120	0.618	2.488	2.213	0.621
2⅝	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2¾	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2⅞	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	3.000	2.550	0.750	2.997	2.540	0.745	2.990	2.546	0.745	2.990	2.540	0.747
	2.998	2.548	0.748	2.996	2.538	0.743	2.988	2.545	0.743	2.988	2.538	0.746
3¼	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

For soft gear and soft shaft fit allowance—0.001 to 0.002 in. less than table.
For hard gear and hard shaft fit allowance—0.001 to 0.002 in. more than table.

FIT ALLOWANCES FROM MAXIMUM SIZE FOR SOFT SHAFT AND HARD GEAR

Nom. Dia., In.	Large Diameter Fit, In.			Small Diameter Fit, In.			Spline Side Fit, In.		
	D_1	d_1	W_1	D_2	d_2	W_2	D_3	d_3	W_3
1¾ and smaller....	0.002	0.010	0.005	0.010	0.002	0.005	0.010	0.010	0.002
	0.003	0.012	0.007	0.012	0.003	0.007	0.012	0.012	0.003
2 and larger....	0.003	0.010	0.005	0.010	0.003	0.005	0.010	0.010	0.003
	0.004	0.012	0.007	0.012	0.004	0.007	0.012	0.012	0.004

than with a 1¼ or a 1½-in. It was recommended that all oversize carbureters be equipped with the next size standard S. A. E. flange. Applying this ruling to the 1⅜-in. carbureter, the flange to use in this case should be the 1½-in. S. A. E. standard.

Fuel and Pipe Markings.—The division recommends that, following aeronautic practice, the fuel and pipe lines be marked with colored bands ½ in. wide, one near each end, and intermediate bands not more than 24 in. apart to designate their service as follows:

Fuel pipes	Red
Lubrication pipes	White
Air pipes	Blue

Flywheel Housing.—It was the consensus of opinion that the standard S. A. E. housing is not heavy enough to properly support the transmission in a tractor. In view of this, a sub-committee was appointed to investigate the present S. A. E. equipment and to make recommendation for the two conditions, when no frame is used and when frame is used. This committee consists of T. C. Menges, R. B. Shoop and J. B. Foot.

Height of Drawbar.—Since this height was recommended for standard at the June, 1917, meeting of the Society it has been found not practicable for pulling disk plows and for some forms of mold boards. It is suggested that the recommendation for standard be changed to read 17 in. maximum and 10 in. minimum. This matter will be considered carefully before making any change in the present standard.

Aeronautic Division Meeting

TURNBUCKLES

REFERENCE was made on page 248 of the March JOURNAL to the March 11 meeting of the Aeronautic Division at Dayton, Ohio, at which the subject of standardization of turnbuckles was taken under consideration by a joint committee of the turnbuckle and airplane manufacturers and the Turnbuckle Committee of the S. A. E. Aeronautic Division. The illustration below and the accompanying table represent the recommendations of this joint committee. Subsequently the recommendations were submitted to representatives of the Navy and the Signal Corps, and their suggestions have been incorporated in the illustrations. The recommendations are presented here in order to encourage constructive criticism for the benefit of the committee.

The objects sought in this tentative turnbuckle standard are as follows:

(1) Standard A.S.M.E. threads below ¼ in. and standard S.A.E. threads for ¼ in. diameter and above.

(2) Two definite lengths—a short turnbuckle 4½ in. between eyes and a long one 8 in. between eyes.

(3) Selective turnbuckle make-up, maintaining definite long and short dimensions for selective assembly of ends.

(4) Interchangeability (with respect to fork and eye dimensions) with 80 per cent of the turnbuckles now in use.

Specifications

Barrels shall be made of naval brass or equivalent alloy having a minimum tensile strength of 67,000 lb. per sq. in., minimum yield point of 45,000 lb. per sq. in., 22 per cent and reduction of area 45 per cent. Rods shall, without fracture, stand being bent, cold, through an angle of 180 deg. and to a radius equal to the diameter of the rod.

The turnbuckle ends shall be made of alloy steel having a minimum tensile strength of 125,000 lb. per sq. in., minimum yield point 95,000 lb. per sq. in., elongation in 2 in. 17 per cent, and minimum reduction of area 50 per cent.

Physical Properties and Tests

(a) At least 2 per cent of all turnbuckles shall be subjected to the test load given in the table and must withstand this test when threads are flush with the end of the barrel.

(b) Steel turnbuckle shanks shall be heat treated to withstand the test loads specified.

(c) A bend test shall be made upon the (unbroken) shank of each turnbuckle tested in tension; the shank must withstand bending through 90 deg. without cracking.

Dimensions and Tolerances

Threads must have a snug true fit, allowing the barrel or shank to be turned by hand and showing no perceptible slackness in fit or end shake with three threads exposed.

The present practice of selective assembly is permissible and gages are to be used only at the discretion of the manufacturer.

Finish

Turnbuckles shall be finished smooth and free from tool marks.

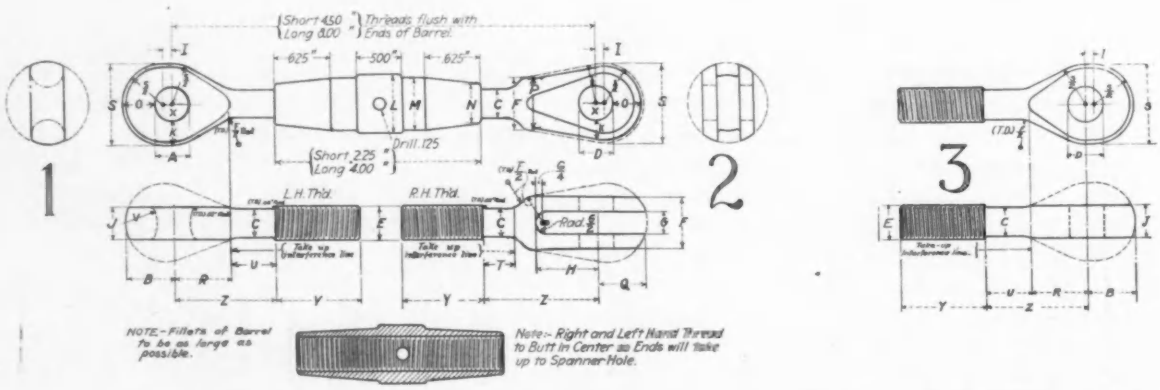


FIG. 1—DIMENSIONS OF PROPOSED S. A. E. TURNBUCKLE (SEE TABLE PAGE 309)

DIMENSIONS OF PROPOSED S.A.E. TURNBUCKLE

	GENERAL					EYE END (SEE SKETCHES 1 AND 3, FIG. 1) ULTIMATE STRENGTH, 125,000 LB. PER SQ. IN.															
S. A. E. Symbols (See Key)	Strength,* Turnbuckle and 19-Strand Wire, Lb.	AREA OF STEEL REQ'D, SQ. IN.: Ultimate Strength 105,000 Lb. per Sq. In.	AREA OF STEEL REQ'D, SQ. IN.: Ultimate Strength 125,000 Lb. per Sq. In.	Wire Diam., In.	Take-up from Threads Flush With End of Barrel to Spanner Holes, In.	Will Take 0.018 In. Serving. Use Same Size Thimble as Cable Size	Equals $\frac{S+I}{2}$	Allows Approx. 0.015 In. Below Root Dia. of Thread	Thimble Radius				AREA TOTAL SECTION, SQ. IN.	AREA TOTAL SECTION, SQ. IN.	Equals $\frac{S+C}{2}$ Approx.	Five Sizes, Same as Fork End	TAKE-UP BASED ON ROOT DIAM. U	TAKE-UP BASED ON ROOT DIAM. U	Area of Hole A		
						A	B	C	V	E	I	J	K	O	R	S	Take-Up	Root Dia.	X	Y	Z
Tolerances	....	.....	.....	....	....	+.010 −.000		+.006 −.000		+.000 −.004		+.000 −.005			+.010 −.010	+.005 −.005				+.040 −.000	+.030 −.010
16 S 12	1600	.0152	.0128	.109 (7/64)	1.02	.219 (7/32)	.28	.133	.175	.190 (#10)	.03	.188 (3/16)	.0466	.0292	.326	.500 (1/2)	0.80	.1467	.0376	.505	1.125 (1 1/8)
16 L 12	1600	.0152	.0128	.109 (7/64)	2.77	.219 (7/32)	.28	.133	.175	.190 (#10)	.03	.188 (3/16)	.0466	.0292	.326	.500 (1/2)	0.67	.1467	.0376	.505	2.000
21 S 12 †21 SN 12	2100	.0200	.0168	.125 (1/8)	1.00	.219 (7/32)	.28	.155	.175	.216 (12)	.03	.188 (3/16)	.0470	.0285	.328	.500 (1/2)	0.59	.1696	.0376	.557	1.125 (1 1/8)
21 L 12 †21 LN 12	2100	.0200	.0168	.125 (1/8)	2.75	.219 (7/32)	.28	.155	.175	.216 (12)	.03	.188 (3/16)	.0470	.0285	.328	.500 (1/2)	1.47	.1696	.0376	.557	2.000
32 S 12 †32 SN 12	3200	.0304	.0256	.156 (5/32)	0.62	.281 (9/32)	.353	.189	.200	.250 (1/4)	.04	.219 (7/32)	.0676	.0422	.402	.625 (5/8)	0.69	.2037	.0621	.725	1.125 (1 1/8)
32 L 12 †32 LN 12	3200	.0304	.0256	.156 (5/32)	2.37	.281 (9/32)	.353	.189	.200	.250 (1/4)	.04	.219 (7/32)	.0676	.0422	.402	.625 (5/8)	1.56	.2037	.0621	.725	2.000
46 S 12	4600	.0438	.0368	.188 (3/16)	0.66	.313 (5/16)	.384	.243	.250	.3125 (5/16)	.04	.281 (9/32)	.0926	.0574	.465	.688 (11/16)	0.68	.2584	.0767	.750 (3/4)	1.125 (1 1/8)
46 L 12	4600	.0438	.0368	.188 (3/16)	2.41	.313 (5/16)	.384	.243	.250	.3125 (5/16)	.04	.281 (9/32)	.0926	.0574	.465	.688 (11/16)	1.56	.2584	.0767	.750 (3/4)	2.000
61 S 12	6100	.0584	.0488	.219 (7/32)	0.38	.344 (11/32)	.435	.256	.300	.375 (3/8)	.06	.281 (9/32)	.1004	.0611	.503	.750 (3/4)	0.67	.3209	.0928	.875 (7/8)	1.125 (1 1/8)
61 L 12	6100	.0584	.0488	.219 (7/32)	2.12	.344 (11/32)	.435	.256	.300	.375 (3/8)	.06	.281 (9/32)	.1004	.0611	.503	.750 (3/4)	1.55	.3209	.0928	.875 (7/8)	2.000
80 L 12	8000	.0760	.0640	.250 (1/4)	2.16	.375 (3/8)	.498	.306	.350	.375 (3/8)	.06	.328 (21/64)	.1500	.0933	.619	.875 (7/8)	1.37	.3209	.1105	.875 (7/8)	2.000

*Breaking strength of spliced wire is about 10 per cent less than undisturbed wire. All Dimensions in Inches

KEY TO SYMBOLS—The first numbers indicate the turnbuckle strength in hundred pounds. The following letter, "Short" or "Long." The following figures, the combination of ends, "1" for eye and "2" for fork end. When the turnbuckle make-up calls for ends to be alike, one end shall have right hand, and the other end left hand thread.

†"N" denotes narrow slot in fork end.

	BARREL					FORK END (SEE SKETCH 2, FIG. 1) ULTIMATE STRENGTH, 125,000 LB. PER SQ. IN.																				
S. A. E. Symbols (See Key)	TOBIN BRONZE, ULTIMATE STRENGTH 67,000 LB. PER SQ. IN.			Thds.	Thds.	ALLOWS APPROX. 0.15 IN. BELOW ROOT DIA. OF THREAD C	C	C STRENGTH	C STRENGTH	3 Hole Diam. (Formerly 4)		3 Pin Lengths (Formerly 5)	4 Clip Thicknesses: 1-10, 1/8, 3/16, 1/4 In.			AREA TOTAL SECTION, SQ. INCHES	AREA TOTAL SECTION, SQ. INCHES	AREA TOTAL SECTION, SQ. INCHES			TAKE-UP BASED ON ROOT DIAM. T	TAKE-UP BASED ON ROOT DIAM. T	Area of Hole D	Equals 2E+.125 In.	Two Lengths, Short and Long Barrels
	L	M	N	Diam.	Pitch	Diam.	Area, Sq. In.	105,000 Lb. per Sq. In.	125,000 Lb. per Sq. In.	D	E	F	G	H	I	K	O	P	Q	S	Take-up	Root Diam.	X	Y	Z
Tolerances	.....	......	....	.	..	..	...	...	...	+.010 −.000	+.000 −.004	+.005 −.005	+.010 −.000	+.010 −.005	.	...	...	...	..	+.005 −.005	...	...	...	+.040 −.000	+.030 −.010
16 S 12	.375 (3/8)	.281 (9/32)	.250 (1/4)	#10	32 ‡	.133	.0139	.1450	.1738	.188 (3/16)	.190	.313 (5/16)	.109 (7/64)	.469 (15/32)	.03	.0520	.0322	.0494	.268	.500 (1/2)	0.510	.1467	.0276	.505	1.125 (1 1/8)
16 L 12	.375 (3/8)	.281 (9/32)	.250 (1/4)	#10	32 ‡	.133	.0139	.1450	.1738	.188 (3/16)	.190	.313 (5/16)	.109 (7/64)	.469 (15/32)	.03	.0520	.0322	.0494	.268	.500 (1/2)	1.385	.1467	.0276	.505	2.000
21 S 12 †21 SN 12	375 (3/8)	.328 (21/64)	.281 (9/32)	#12	28 ‡	.155	.0189	.1985	.2360	.188 (3/16)	.216	.313 (5/16)	.140 (9/64) *.109 (7/64)	.500 (1/2)	.03	.0440	.0280	.0420	.260	.500 (1/2)	0.500	.1696	.0276	.557	1.125 (1 1/8)
21 L 12 †21 LN 12	.375 (3/8)	.328 (21/64)	.281 (9/32)	#12	28 ‡	.155	.0189	.1985	.2360	.188 (3/16)	.216	.313 (5/16)	.140 (9/64) *.109 (7/64)	.500 (1/2)	.03	.0440	.0280	.0420	.260	.500 (1/2)	1.375	.1696	.0276	.557	2.000
32 S 12 †32 SN 12	.438 (7/16)	.391 (25/64)	.328 (21/64)	1/4	28 §	.189	.0280	.2940	.3500	.250 (1/4)	.250	.438 (7/16) *.344 (11/32)	.203 (13/64) *.109 (7/64)	.625 (5/8)	.04	.0628 .0712	.0424 .0496	.0830 .0864	.320	.625 (5/8)	0.310	.2037	.0491	.725	1.125 (1 1/8)
32 L 12 †32 LN 12	.438 (7/16)	.391 (25/64)	.328 (21/64)	1/4	28 §	.189	.0280	.2940	.3500	.250 (1/4)	.250	.438 (7/16) *.344 (11/32)	.203 (13/64) *.109 (7/64)	.625 (5/8)	.04	.0628 .0712	.0424 .0496	.0830 .0864	.320	.625 (5/8)	1.185	.2037	.0491	.725	2.000
46 S 12	.500 (1/2)	.438 (7/16)	.406 (13/32)	5/16	24 §	.243	.0464	.4870	.5790	.250 (1/4)	.3125	.438 (7/16)	.203 (13/64)	.625 (5/8)	.04	.0880	.0500	.0820	.350	.688 (11/16)	0.330	.2584	.0491	.750 (3/4)	1.125 (1 1/8)
46 L 12	.500 (1/2)	.438 (7/16)	.406 (13/32)	5/16	24 §	.243	.0464	.4870	.5790	.250 (1/4)	.3125	.438 (7/16)	.203 (13/64)	.625 (5/8)	.04	.0880	.0500	.0820	.350	.688 (11/16)	1.205	.2584	.0491	.750 (3/4)	2.000
61 S 12	.625 (5/8)	.594 (19/32)	.469 (15/32)	3/8	24 §	.256	.0515	.5400	.6430	.375 (3/8)	.375	.563 (9/16).	.203 (13/64)	.688 (11/16)	.06	.0890	.0660	.1520	.405	.750 (3/4)	0.190	.3209	.1105	.875 (7/8)	1.125 (1 1/8)
61 L 12	.625 (5/8)	.594 (19/32)	.469 (15/32)	3/8	24 §	.256	.0515	.5400	.6430	.375 (3/8)	.375	.563 (9/16)	.203 (13/64)	.688 (11/16)	.06	.0890	.0660	.1520	.405	.750 (3/4)	1.060	.3209	.1105	.875 (7/8)	2.000
80 L 12	.625 (5/8)	.594 (19/32)	.469 (15/32)	3/8	24 §	.306	.0735	.7720	.9170	.375 (3/8)	.375	.563 (9/16)	.266 (17/64)	.688 (11/16)	.06	.1060	.0704	.1360	.455	.875 (7/8)	1.080	.3209	.1105	.875 (7/8)	2.000

*This width to be used only with alloy steel clip having an ultimate strength of 125,000 lb. per sq. in. ‡A.S.M.E. §S.A.E. All Dimensions in Inches

Protective Coating

Turnbuckle barrels and shanks, exclusive of threads, shall be*.............., to provide a non-corrosive surface to prevent rust. The threads are to be thoroughly greased in both barrel and shank to prevent rust.

The Actual Dimensions

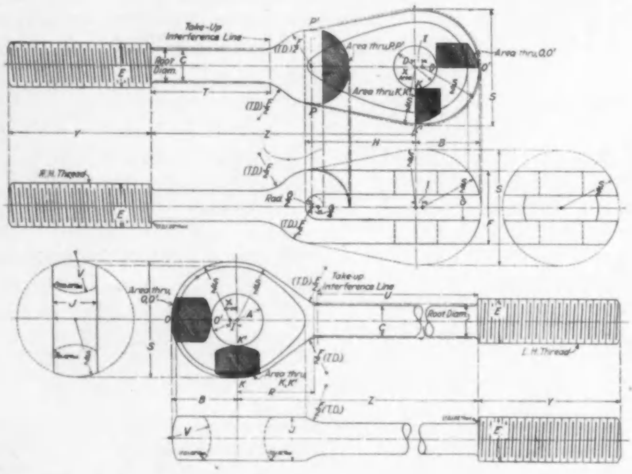
For convenience of analysis, the required section area is noted for both the 105,000 lb. and the 125,000 lb. steel to give the required cable strength.

A numbering system will be useful to indicate the make-up of the turnbuckle; it is suggested that the

Fork end be indicated by the letter *F*.
Eye end be indicated by the letter *E*.
Clip end be indicated by the letter *C*

in place of the figures 1, 2 and 3 shown on the illustration.

When the illustration and specifications receive approval for standard, the detail analytical information will be omitted from the drawing and essential tables of dimensions only will remain.



ANALYSIS OF EYE AND FORK ENDS OF PROPOSED S. A. E. TURNBUCKLE

The Dayton meeting, March 11, was attended by the following:

F. W. Caldwell, McCook Field, Dayton, Ohio; F. E. Cardullo, Curtiss Aeroplane Co., Buffalo, N. Y.; William C. Chadeayne, Curtiss Engineering Corps, Buffalo, N. Y.; J. V. Costello, McCook Field, Dayton, Ohio; Albert B. Hilton, Jr., Dayton Metal Products Co., Dayton, Ohio; Roland V. Hutchinson, Dayton Wright Airplane Co., Dayton, Ohio; J. F. McClelland, McCook Field, Dayton, Ohio; R. D. Oldfield, Western Automatic Machine Screw Co., Elyria, Ohio; A. M. Orr, National Aeroplane Co., Chicago, Ill.; C. E. Russell, Dayton Metal Products Co., Dayton, Ohio; G. W. Tidd, Willys-Morrow Co., Elmira, N. Y.; Paul G. Timmerman, Engel Aircraft Co., Niles, Ohio; G. H. Weith, Dayton Metal Products Co., Dayton, Ohio; J. C. Wilkie, Western Automatic Machine Screw Co., Elyria, Ohio; Standards Manager M. W. Hanks.

*To be determined later.

MEMBERSHIP COMMITTEE ACTIVITIES

THE Membership Committee of the Society, under the leadership of Chairman C. C. Hinkley, has been extending its activities during the past month to include practically every state of the Union in which there are members of the Society. The names of the organization which has been invited to supervise the work in the different states are given below, as is also the number of new members the leaders have been requested to secure during the current calendar year. The number of S. A. E. members in each state on Jan. 1, 1918, has been taken as a basis in calculating the membership increase figures, which will, it is hoped, be greatly exceeded when the final returns for the year are compiled.

OUTLINE OF MEMBERSHIP ORGANIZATION

State	State Leader	New Members — Total Desired in 1918	Per Cent Secured Up to April 10
Arkansas	J. P. Eberle, Fort Smith	5	0
California	J. W. White, Jr., Oakland	40	37.5
Colorado	O. P. Fritchle, Denver	4	0
Connecticut	F. P. Gilligan, Hartford	56	8.9
District of Columbia	John R. Cautley, Washington	67	7.5
Delaware	E. R. Armstrong, Wilmington	5	0
Florida	G. M. De Witt, Jacksonville	5	0
Georgia	E. H. Gunster, East Point	5	20.0
Illinois	P. E. Stone, Chicago	188	12.8
Indiana	W. S. Reed, Indianapolis	121	12.4
Iowa	S. E. Hanselman, Des Moines	19	15.8
Kansas	C. L. Coggins, Wamego	5	0
Kentucky	H. J. Walker, Newport	5	0
Maine	P. H. Adams, Portland	5	0
Maryland	E. E. Richmond, Baltimore	7	14.3
Massachusetts	K. W. Moynes, Boston	70	24.3
Michigan	W. C. Little, Detroit	364	5.2
Minnesota	R. B. Shoop, Minneapolis	40	17.5
Missouri	G. P. Dorris, St. Louis	17	11.8
Nebraska	L. F. Seaton, Lincoln	5	0
New Hampshire	A. L. Clough, Manchester	5	0
New Jersey	C. A. Schell, Trenton	94	9.6
New York	L. I. Stewart, New York	410	6.1
North Carolina	W. S. Corbitt, Henderson	5	0
North Dakota	O. L. Curtis, Fargo	5	20.0
Ohio	H. E. Figgie, Cleveland	270	8.9
Oklahoma	E. P. Kirchofer, Tulsa	5	0
Oregon	G. M. Flint, Portland	5	0
Pennsylvania	J. A. Anglada, Philadelphia	143	3.5
Rhode Island	L. R. Davis, Providence	5	0
South Carolina	L. A. Prince, Sumter	6	0
Tennessee	J. V. Giesler, Knoxville	5	20.0
Texas	L. D. Ormsby, San Antonio	7	14.3
Vermont	E. W. Miller, Springfield	5	0
Virginia	C. B. Buxton, Richmond	8	0
Washington	R. S. Taylor, Seattle	5	60.0
West Virginia	G. B. Chorpening, Clarksburg	3	0
Wisconsin	S. F. Briggs, Milwaukee	70	21.4

The percentages given in the above table are in a way an index of the membership activities in the different states during the last few months of 1917. They will probably be subject to considerable change in the near future, as the various organizations get into action.

Activities of S. A. E. Sections

THE present administrative year of all sections expires April 30, so that the April meetings, in addition to the usual technical features, will be devoted to reports on the business done during the year and to the election of officers for the ensuing year. Not all of the sections will hold meetings during May, but plans are being made to secure a large attendance of the different section members at the Dayton meeting of the Society in June.

Buffalo Section.—The last automotive meeting of the season of the Buffalo Engineering Society will be held April 24, when F. W. Gurney will present, under the auspices of the Buffalo Section of the Society, a paper on design, manufacture and application of ball bearings.

Cleveland Section.—Johnson Heywood, of the editorial staff of *Factory*, gave a paper on inspection at the April 19th meeting of the Section. Supplementing Mr. Heywood's talk, there were a number of five-minute addresses, under the direction of W. C. Keys, by chief inspectors of automotive plants in Cleveland.

At the May meeting, which is to be held on the 17th, R. B. Lea of the Sperry Gyroscope Company will give a paper on the useful applications of the gyroscope.

Detroit Section.—The April meeting of the Section will be held on the 26th. A paper on the subject of engineering problems in modern gun-making will be given by Lieut. W. Z. W. Skeritt. The plans for the May meeting have not yet been announced.

Indiana Section.—The April and May meetings are to be held on the last Friday of the month, and while the program has not yet been definitely settled, it is expected that B. R. Tewksbury will discuss the subject of tractors at the April meeting and that R. T. Stranahan will speak on spark-plugs at the May meeting.

Metropolitan Section.—The regular meeting of the section will be held on the 24th of April at the Automobile Club of America. B. R. Tewksbury of Cleveland will give a paper on the application of tractors in railway and industrial service. It is expected that this will be illustrated by lantern slides and motion pictures. W. P. Kennedy of the Section will also present a discussion on the tractor subject. The Section hopes to have an address made by President Kettering at the May meeting, although final plans for this have not yet been settled.

Minneapolis Section.—On May 1 the last meeting of the year will be held. A. F. Moyer of the engineering experimental department, University of Minnesota, will present a paper on resistance to rolling of tractor wheels. Mr. Moyer has been working for some time on this problem and will have some interesting data to present to the tractor engineers of the Minneapolis Section.

W. G. Clark of the Wilcox-Bennett Carburetor Company presented a paper on Tractor Engine Lubrication and Lubricating Oils at the April 3 meeting. This described a series of tests made to determine the relative operating value of different oils. W. G. G. Godron of the Vacuum Oil Company gave an interesting account of recent developments in European types of Diesel engines.

Mid-West Section.—At the April meeting of the Section, which is to be held on the 26th at the Chicago Automobile Club, H. T. Sward of Fairbanks, Morse & Company will discuss oil burning tractor engines, and J. G. Zimmerman of the Sumter Electrical Company will give a paper on a subject to be announced later. The Section will hold no meeting in May, but on June 4 it is making arrangements to have a joint technical session with the National Gas Engine Association, which is then holding its annual convention in Chicago. This will be held on the afternoon of June 4, and a dinner is to be given under the auspices of the Mid-West Section on the evening of that day. At the technical session C. B. Blakely, chief engineer and gas engine expert of Sears-Roebuck Company, will discuss the relation of the Hvid engine to the poppet valve and Diesel types. An address on ignition problems will be made by H. R. Van Deventer.

Pennsylvania Section.—The final meeting of the year of this Section will be held on the 26th, at the Engineers' Club, Philadelphia. The election of officers will take place at this meeting, and it is planned to have an address on some topic connected with the war. The Section plans to hold its annual outing some time during the summer, the details to be announced later.

STEEL AND VARIABLE-PITCH AIRPLANE PROPELLERS

THE National Advisory Committee for Aeronautics desires to invite the attention of all designing engineers, and particularly those interested in propeller design, to two very important problems now confronting the air services of the nation, namely, a steel air propeller and a variable-pitch air propeller.

The special subcommittee on engineering problems, consisting of Messrs. Durand (chairman), Stratton, Zahm, Dickinson, Chase and Loening, has reported that these problems have been under consideration for some time but so far without attaining satisfactory results.

These problems require careful mathematical study by technicians fully equipped with a sound understanding of the fundamental principles of aeronautical and structural engineering.

The ideal variable-pitch propeller should embody means for changing simultaneously the diameter, area, and pitch for changes in air density. It is not necessary that design of the steel propeller follow the present practice in wooden air propellers, but after careful consideration has been given to the aerodynamical principles involved, design and experimental work should follow fundamental structural engineering practice. The development of such propeller should be coincident with the development of the variable-pitch propeller.

Aeronautical engineers and other technicians are invited to give thought to this problem and submit brief descriptions of their ideas with such drawings, data, and photographs as are necessary, to the National Advisory Committee for Aeronautics, Munsey Bldg., Washington.

REPORT OF MARCH COUNCIL MEETING

AT an informal meeting of the Council held March 25 at Detroit the following were present: President C. F. Kettering, First Vice-president David Beecroft, Second Vice-president C. C. Hinkley, and Councilor J. V. Whitbeck.

Chairman Beecroft of the Meetings Committee of the Society outlined plans proposed for the Semi-Annual Meeting, which is to be held June 17 and 18 at Dayton. The meeting will be held in Triangle Park, Dayton, with a dinner on the evening of the 17th and professional and business sessions Monday and Tuesday morning and afternoon and probably Tuesday evening. It is proposed to exhibit different types of automotive apparatus designed particularly for military purposes, these to be arranged for their educational value in promoting the war program.

Chairman Hinkley of the Membership Committee reported that the country had been divided into state zones and subdivided into districts with members of the Society designated as leaders for their zones and districts. Suggestions as to the method of securing desirable additional members to the Society have already been sent to these leaders in order to help on the work.

It was voted to make the following transfers in grade of membership: From Associate to Member grade, Stephen A. Ellett, Alex. B. C. Hardy, E. L. Harkness, Arthur J. Hazen, W. J. McIntyre, Ralph F. Rogers, Fletcher Schaum, Chas. M. Schwab, Harold A. Soulis, and Claude A. Wales. From Junior to Member, Wallace B. Blood and A. L. Kimball.

It was reported to the Council that a number of members elected late in the 1916-1917 fiscal year and paying dues for that period had not received the publications to which they are entitled under the Constitution. In view of the situation it was voted that, subject to approval at the next meeting of the Society, these members be credited with a sum equal to dues paid by them for the period during which the Society was unable to furnish publications.

Applicants to the number of 85 were elected to membership in the Society, these being assigned to grades as follows: 32 Members, 29 Associate Members, 20 Junior Members, 1 Affiliate Member, and 3 Student Enrollments.

The Council considered a joint report from the Constitutional and Membership Committees regarding the amendments proposed to the Constitution of the Society at the Annual Meeting held in New York in January. The two committees recommended a number of changes in the wording of the proposed amendments. These were approved by the Council with instructions that they should be sent out to the voting membership of the Society as required under the Constitution (at least 60 days previous to the Semi-Annual Meeting) accompanied by the comment of the Council that the suggested changes are in form only in order to make the amendments uniform in style with other sections of the Constitution.

An advertisement of a tractor company containing the statement, "There are no parts or material used in the construction of the —— tractor which do not have the endorsement of the Society of Automotive Engineers," was discussed by the Council and it was decided that a letter be addressed to the tractor company asking that the use of the name of the Society be discontinued.

A number of changes in the personnel of the Standards Committee were approved by the Council. W. A. Chryst was made chairman of the Electrical Equipment Division in place of A. L. Riker, who was unable to serve.

The Nomenclature Division will be as follows:

F. R. Hutton, Chairman	Raymond Olney
P. M. Heldt	Leigh M. Griffith
N. B. Pope	R. O. Gill
H. R. Cobleigh	Herbert Chase.

E. F. Kenney was made a member of the Committee with assignment to the Iron and Steel Division.

The following Springs Division was approved: C. W. McKinley, chairman; E. W. Acker, Harry R. McMahon, R. L. Morgan and W. M. Newkirk. At the suggestion of the Council several other members will be added to this Division, the names to be announced later.

The Stationary and Farm Engine Division consists of the following: Chas. Kratsch, chairman; H. W. Edens, L. S. Keilholtz, F. J. Lemley, Theo. Menges and L. M. Ward.

G. H. Lewis was appointed on the Standards Committee with assignment to the Tire and Rim Division.

The following subjects were approved for consideration by the divisions named:

Ball and Roller Bearings Division.—Cup and cone bearings, thrust bearings, metric sizes, marine thrust bearings, and review of tolerance for Anglo-American Conference.

Marine Division.—Standardized motor lifeboat units, boat fittings.

Nomenclature Division.—Aeronautic, tractor, marine, truck, and motorcycle nomenclature.

Springs Division.—Spring-shackle bolts and nuts, finish of springs, width of spring brackets, spring clips, spring dimensions, and length of spring feet.

A written report was received from Chairman C. S. Crawford of the Sections Committee, suggesting that the committee should prepare standard forms for all section activities, these to include the letterheads, financial reports, membership applications, as well as the section constitutions and by-laws. The Council approved the action of the Governing Committee of the Indiana Section, by which the section adopted in complete form, with the necessary change of name, the by-laws now in use by the Minneapolis Section. This action was taken in order to promote standardization of the different section by-laws.

It was suggested by the Sections Committee that a booklet be prepared for the use of the section officers, this to contain rules of order, information regarding important section activities and other useful data.

A report was presented to the Council that Councilor H. L. Horning and Assistant Secretary Herbert Chase had represented the Society at a meeting held March 20 at the Bureau of Standards and attended by representatives of motor truck users and different departments of the Government. At this meeting it was suggested that a committee be formed to investigate the possibility of using kerosene as fuel in existing types of motor trucks. It was the sense of the Council that the Society might properly cooperate in the work of this committee, providing its activities were confined to research work regarding the broad principles involved.

The next meeting of the Council will be held Monday, April 22, in Dayton, Ohio.

PERSONAL NOTES OF THE MEMBERS

THE SOCIETY desires to be advised from time to time as to changes in positions and connections of the members in order to keep its membership informed, and will, therefore, appreciate any information of this nature. No attempt has been made in this issue to include the large number of changes received for the 1918 S.A.E. Membership List as this will probably be available soon after the publication of the May issue of THE JOURNAL.

John P. Ahrens of the The Ahrens-Fox Fire Engine Co., Cincinnati, is now sales manager and vice-president.

W. D. Appel, formerly doing special engineering work, is now motor engineer with the Steel Products Co., Cleveland.

N. W. Akimoff, formerly research engineer, Harrison Bldg., Philadelphia, is now president and general manager, Vibration Specialty Co., Harrison Bldg., of the same city.

D. W. Burke is now president and general manager, Auto Electric & Service Co., Detroit.

Harold N. Bliss, formerly production manager, engine department, Thomas-Morse Aircraft Corp., is now superintendent, engine department.

Frederick E. Brown, formerly assistant to second vice-president, Shelby Steel Tube Co., Pittsburgh, is now assistant to vice-president, National Tube Co., Pittsburgh.

Francis H. Baker, formerly designer, Curtiss Engineering Corp., Garden City, New York, is now automotive engineer at 1310 Park Ave., Plainfield, N. J.

Owen R. Baker, formerly sales manager, Doehler Die Casting Co., Toledo, Ohio, is now president of the Owen R. Baker Co., Detroit.

F. H. Berger has severed his connection as chief engineer, Abbott Corp., Cleveland.

W. J. Behn, formerly chief engineer, Detroit Taxicab & Transfer Co., Detroit, is division sales manager, Wasson Piston Ring Co., New Brunswick, N. J., at Detroit.

W. S. Corbitt, chief engineer, Corbitt Motor Truck Co., Henderson, N. C., is also treasurer of the same company.

Sidney W. Colvard, formerly inspection engineer, Curtiss Aeroplane & Motor Corp., Buffalo, is now assistant general inspector and foreman, Factory E.

L. K. Clark, formerly at San Antonio, Tex., is now with the Standard Motor Sales Co. of San Antonio, Tex.

Lee C. Carlton, formerly San Francisco branch manager, Bosch Magneto Co., is now manager of the Chicago branch.

Robert Crawford, formerly president and general manager, Sun Motor Car Co., Elkhart, Ind., is with The Automotive Corp., Chicago.

H. G. Diefendorf, is no longer with the Gray Motor Co., Detroit.

F. M. Dampman, formerly salesman, Motor Vehicle Publishing Co., New York, is now president, Keystone Garage Equipment Co., New York.

Austin W. Deyo, chief engineer, Larrabee-Deyo Motor Truck Co., Inc., Binghamton, N. Y., is also assistant general manager.

A. O. Dady, sales engineer of the Pfanstiehl Co., Inc., is now located at the plant, North Chicago, Ill.

Edward Dixon, formerly chief engineer and production manager, Dayton-Dick Co., Quincy, Ill., is now production manager and supervising engineer, Oneida Motor Truck Co., Green Bay, Wis.

John P. Eberle, formerly stock man and service work, Cronniher & Triesch, at Chicago, is now at Fort Smith, Okla.

C. A. Erickson, formerly chief engineer, Scripps-Booth Co., Detroit, is now general manager, Standard Radiator Co., Springville, N. Y.

Gregory Flynn, formerly sales manager, Rajah Auto Supply Co., Bloomfield, N. J., is now assistant to president, Edw. A. Cassidy Co., Inc., New York.

Kanaye Fujita, formerly engineer, Mitsui & Co., New York, is now in engine department, Kawasaki Dockyard Co., Kobe, Japan.

Noble Foss of the Sturtevant Aeroplane Co., Jamaica Plain, Boston, Mass., is now president and general manager.

Herman G. Farr, formerly consulting engineer at Springfield, Mass., is now consulting engineer with the Martin Rocking Fifth Wheel Co., Springfield, Mass.

Geo. B. Fuller, formerly aeronautical mechanical engineer, Aviation Section, Signal Corps, Dayton, is now assistant chief engineer, Glenn L. Martin Co., Cleveland.

N. Lincoln Green, formerly vice-president and manager, American Rubber Co., Boston, Mass., is now manager, Clothing Division, U. S. Rubber Co., Boston, Mass.

Howard S. Gardner, formerly district manager, Willard Storage Battery Co., Chicago, is now general manager and president, Mid-West Storage Battery Co., Kansas City, Mo.

E. K. Hill, formerly in engine department, Thomas Morse Aircraft Corp., Ithaca, New York, is now in inspection department, Simplex Works, Wright-Martin Aircraft Corp., New Brunswick, N. J.

C. M. Hyde has severed his connections as assistant purchasing agent of the Packard Motor Car Co., Chicago.

L. H. Hazard is now production manager, Velie Motors Corp., Moline, Ill.

J. F. Guider, formerly superintendent of manufacturing, Pierce-Arrow Motor Car Co., Buffalo, is now vice-president, in charge of manufacturing, Cadillac Motor Car Co., Detroit.

Clarence F. Jamison, formerly president and general manager, Supreme Motors Corp., Cleveland, is now assistant general manager, Elgin Motor Car Corp., Chicago, Ill.

Wm. E. Kemp, formerly eastern and foreign distributor, Byrne Kingston & Co., Kokomo Electric Company, Kokomo, Ind., at New York, is now distributor of Kingston specialties at New York.

V. C. Kloepper, formerly chief draftsman, is now designing engineer, Dorris Motor Car Co., St. Louis, Mo.

Guy A. Little, formerly in dynamometer department, is assistant to chief inspection engineer, Curtiss Aeroplane & Motor Corp., Buffalo.

Arthur C. Leverton, formerly vice-president, H. L. & W. Sales & Mfg. Co., Detroit, is now factory manager, Federal Motor Truck Co., Detroit.

Willis Sargent Leggett, Jr., formerly specialist on electric apparatus for automobiles, General Electric Co.

at Cincinnati, is now with the same company at Cleveland.

C. A. McCutcheon is now sales engineer for the Salisbury Wheel & Axle Co., Jamestown, N. Y.; Peru Auto Parts Co., Peru, Ind.; Norwalk Auto Parts Co., Norwalk, Ohio; Jamestown Radiator Co., Jamestown, N. Y., and is located at Jamestown, N. Y.

H. C. Maibohm, formerly vice-president and chief engineer, Maibohm Motors Co., Racine, Wis., is now president of the same company.

Geo. E. Martin, formerly truck engineer, Velie Motors Corp., Moline, Ill., is now chief engineer of the same company.

H. H. Newsom, formerly factory manager, Standard Parts Co., Cleveland, is director of purchases of the same company.

F. D. Norman, formerly branch manager, is now factory manager, Bosch Magneto Co., Springfield, Mass.

Thomas T. O'Brien, formerly with the Commercial Car Division of The Willys-Overland, Inc., is now district sales manager for The Commercial Car Unit Co., of Philadelphia.

Austin P. Palmer, formerly electrical engineer, Multiple Jet Carburetor Co., New York, is now electrical consulting engineer at 90 West Street, New York.

Edward V. Rippingille, formerly in the Aircraft Inspection Training Office, Buffalo, is now chief engineer, Hudson Motor Car Co., Detroit.

John J. Rooney is now chief engineer, Briggs Aeroplane Co., Alexandria, Va.

Robert C. Reid, formerly manager, truck department, is now secretary, Harrolds Motor Car Co., New York.

O. P. Redford, formerly superintendent, is now secretary, Richmond Forgings Corp., Richmond, Va.

John Riise, formerly assistant chief truck engineer, International Harvester Corp., Chicago, is now chief engineer, Tractor Department, The Wellman-Seaver Morgan Co., Cleveland.

James Ross, formerly chief engineer, Gile Tractor & Engine Co., Ludington, Mich., is now with the American Manganese Steel Co., Chicago Heights, Ill.

Arthur M. Robbins, formerly president, Centaur Motor Co. of Illinois, Chicago, is now general manager of the Chalmers Motor Sales Co., New York.

Edmund S. Roberts has severed his connection as sales manager, Truck Tire Department, McGraw Tire & Rubber Co., East Palestine, Ohio.

C. T. Schaefer, formerly consulting engineer, St. Louis, Mo., is now chief engineer and factory manager, Globe Motor Truck Co., E. St. Louis, Mo., and also consulting engineer, Midland Motor Car & Truck Co., Oklahoma City, Okla.

I. D. Shaw is now president, Automotive Mfg. Co., Detroit.

E. V. Schaal, formerly in inspection engineering department, is now heat-treatment inspector, Curtiss Aeroplane & Motor Corp.

Henry K. Spencer, mechanical engineer, is now engineer and assistant manager, The Blanchard Machine Company, Cambridge, Mass.

H. M. Swetland, president, The Class Journal Co., New York, is now president of the United Publishers Corp., New York.

Adolph P. C. Schramm, formerly engineer, Klaxon Co., Newark, N. J., is now consulting engineer at 276 Canal Street, New York.

H. Stanley Starling, formerly chief inspector, finished parts and assembly. Bureau Veritas, Simplex Automobile Co., New Brunswick, N. J., is now inspection surveyor at large and assistant to chief engineer, Bureau Veritas, New York.

Carl F. Scott, formerly commercial engineer, is now manager of the specialty apparatus sales, Sprague Electric Works, New York.

D. Sternbergh is now sales and service manager, American Die & Tool Co., Inc., Reading, Pa.

R. B. Stuart, formerly in technical department, Smith Motor Truck Co., Chicago, is with C. E. Knoeppel & Co., New York.

C. W. Taylor is now in fuselage department of the Dayton-Wright Airplane Co., Dayton, Ohio.

H. A. Tarantous, formerly associate editor, is now technical editor, *Motor*, New York.

A. F. Wagner, formerly president and consulting engineer, Wagner-Hoyt Electric Co., New York, is now president, general manager and engineer, Gibraltar Jack Co., Wagner Specialty Co., New York.

Robert Wolfers, formerly publisher, The Associated Blue Book Publications, New York, is now president, *Motor Life*, The Automobile Blue Book Publishing Co. and The Automobile Trade Directory, New York.

A. H. Wyatt, formerly chairman, board of directors, Pan-American Motors Corp., Decatur, Ill., is now sole owner, Sun Motor Car Co., Elkhart, Ind., at Chicago.

Aage E. Winckler, formerly chief engineer and mechanical engineer, Pittsburgh Model Engine Co., Pittsburgh, is now chief engineer and secretary, Lorenz Motors Co., Racine, Wis.

Harold G. Wilson, formerly salesman, Holley Bros. Co., Detroit, is now sales engineer at Detroit of the Tractor Bearings Division, Hyatt Roller Bearing Co., Chicago.

D. B. Webster is now chief engineer of the National Car & Vehicle Corp., Indianapolis.

A. C. Woodbury, formerly in the engineering department, Duesenberg Motors Corp., Elizabeth, N. J., is now in the engineering department of the Chevrolet Motor Co., New York.

WILLIAM C. WENK

The death of William Carleton Wenk occurred on March 16. Mr. Wenk was born May 29, 1868, in Hartford, Conn. After taking a course at Hillyer Institute, he served a machinist's apprenticeship of four years with the Pratt & Whitney Company of Hartford. He then held the position of foreman with the American Mfg. Co., Webster Mfg. Co., Pope Mfg. Co. and at the Schenectady works of the General Electric Co.

For one year, commencing in 1904, Mr. Wenk was superintendent of the H. H. Franklin works at Syracuse, N. Y. During the following year he served as superintendent of Smith & Mabley Co., New York City. For over four years, starting November, 1906, he held the position of chief inspector of the Pierce-Arrow Motor Car Co., and later became superintendent for H. A. Moyer. At the time of his death he was superintendent of the Remington Arms Co. of Delaware, Eddystone, Pa. Mr. Wenk, on Aug. 17, 1910, was elected a Member of the Society.

HONOR ROLL OF SOCIETY MEMBERS

THE following members have recently entered the services of the government in civilian or military capacities. This list, together with the "Service Directory of Members" following, is intended to contain the names of all members connected with the government, either in the military service or in civilian capacities. In both the "Honor Roll" and the "Service Directory" the names are listed in two parts, the first showing the members who have actually entered the military services, and the second those engaged as civilians. Every effort is made to have the addresses correct, but many of the members are changing about so much that it is almost impossible to tell accurately as to just where they are located at any given time. It is therefore requested, in case of any error, that the member concerned immediately inform the New York office of the Society, so that a proper correction can be made. Members who have actually entered the service in any capacity, and who are not listed, should also write the details to the New York office.

Military Service

BIBB, JOHN T., JR., lieutenant, Aviation Section, S. R. C., Love Field, *Dallas, Texas.*

COLLINS, KENNETH G., lieutenant, Aviation Section, U. S. A., A. E. F., *Italy.*

FULTON, RICHARD WALLACE, Aviation Section, Signal Corps., U. S. A., Camp Dick, *Dallas, Texas.*

HALL, C. M., major, Aviation Section, Signal Corps, U. S. A., *Dayton, Ohio.*

HAWKE, CLARENCE E., Aviation Section, Signal Corps, U. S. A., *Washington.*

HECOX, F. C., captain, Quartermaster Corps, U. S. A., *Washington,* assigned to Engineering Bureau, Motor Division, in charge of standardization of military motorcycles.

MCGILL, GEO. E., Equipment Division, Aviation Section, Signal Corps, U. S. A., Packard Motor Car Co., *Detroit.*

MACCOULL, NEIL, JR., U. S. N. R., *Washington.*

OLIPHANT, LAURENCE, ensign, U. S. N., *Washington.*

SMITH, G. W., JR., lieutenant, U. S. N. R., Naval Aircraft Factory, U. S. Navy Yard, *Philadelphia.*

STAHL, R., lieutenant, U. S. Navy Seaplane Division, U. S. N. R., *Washington.*

STEVENS, C. C., Motor Equipment Section, Ordnance Department, U. S. A., *Washington,* assigned as draftsman.

SWEET, GEO. W., captain, Ordnance Department, U. S. A., *Washington,* assigned as inspector of ordnance, Studebaker Corp., *South Bend, Ind.*

THOMPSON, JOHN A., Ordnance Department, U. S. A., assigned to Engineering Bureau, Motor Equipment Section, Ford Bldg., *Washington.*

WALTON, HAROLD E., 84th Aero Squadron, Signal Corps.. U. S. A., Kelly Field, *San Antonio, Texas.*

WEAVER, E. W., mechanical engineer, Naval Aircraft Factory, Navy Yard, *Philadelphia.*

WEISS, ERWIN A., sergeant, Ordnance Department, U. S. A., *Washington,* assigned to Engineering Bureau, Motor Section.

WELSH, W. E., Signal Corps, Aviation Section, U. S. A., *Washington.*

WOLFF, RUDOLPH D., U. S. N. R. F. No. 5, Great Lakes, U. S. A., assigned as chief petty officer.

WOOD, C. G., first lieutenant, Quartermaster Corps, U. S. A., *Washington,* assigned to Motor Transport Section, Office of Quartermaster Corps.

Civilian Service

BACON, CHARLES V., Bureau of Mines, Department of Interior, *Washington,* assigned as chemical engineer and chief of oil research section.

CROW, HAROLD I., School of Military Aeronautics, University of California, *Berkeley, Cal.,* assigned as instructor in aeronautic engines.

LINCOLN, C. W., aeronautical mechanical engineer, Airplane Engine Department, Equipment Division, Signal Corps, U. S. A., *Washington.*

SEABURY, W. WARNER, Signal Corps, U. S. A., Bureau of Standards, *Washington,* assigned to testing of aviation instruments.

SELLERS, MATTHEW B., Naval Consulting Board, *New York.*

Service Directory of Members

Military Service

ALDEN, HERBERT W., lieutenant-colonel, Motor Equipment Section, Carriage Division, Ordnance R. C., *Washington.*

ALDRIN, EDWIN E., lieutenant, Coast Artillery Corps, U. S. A., *Ft. Monroe, Va.,* (mail) 2nd Training Co., *Ft. Monroe, Va.*

AMON, CARL H., Aviation Section, Signal R. C., *Washington.*

ANDERSON, OSCAR G., private, 161st Depot Brigade, Co. 4, U. S. N. A., (mail) Barracks 1488W, Camp Grant, Ill.

ANDERSON, E. S., lieutenant, Aviation Section, Signal Corps, U. S. A., *Gerstner Field, La.*

ANDERSON, WILLIAM C., lieutenant, Engineer R. C., *Brooklyn, N. Y.*

ARNOLD, BION J., lieutenant colonel, Aviation Section, Signal R. C., *Washington.*

BARKER, C. NORMAN, pilot cadet, Royal Flying Corps, *Camp Borden, Can.*

BARTON, W. E., first lieutenant, Quartermaster R. C., *Washington.*

BATES, WM. O., JR., first lieutenant, Motor Equipment Section, Carriage Division, Ordnance R. C., *Washington.*

BIBB, JOHN T., JR., lieutenant, Aviation Section, S. R. C., Lone Field, *Dallas, Texas.*

BLANK, M. H., first lieutenant, Motor Equipment Division, Ordnance R. C., Grant Motor Car Co., *Cleveland.*

BLOOD, HOWARD E., lieutenant, Engine Design Section, Equipment Division, Signal Corps, U. S. A., *Washington.*

BOGGS, GEO. A., lieutenant, Quartermaster Corps, U. S. A.; (mail) Farmers Loan & Trust Co., *Paris, France.*

BOWEN, C. H., captain, Military Truck Production Section, Office of Quartermaster General, *Washington.*

BRITTEN, DANIEL L., captain, Ordnance R. C., *Washington,* assigned to Gun Division, Ordnance Section.

BRITTEN, WM. M., major, engineer of motor transportation, Quartermaster R. C., *Washington.*

BROWN, JULIAN S., U. S. A., (mail) Aviation School, Massachusetts Institute of Technology, *Cambridge, Mass.*

BROWN, HAROLD HASKELL, first lieutenant, Coast Artillery Corps, U. S. N. A., *Fort Totten, N. Y.*

BROWNE, ARTHUR B., captain, Sanitary Corps, U. S. N. A., (mail) General Motors Co., *Detroit.*

CALLAN, JOHN LANSING, lieutenant, Reserve Flying Corps, U. S. N., U. S. S. Seattle, (mail) Postmaster, *New York.*

CAMPBELL, ARCHIBALD F., Aviation Section, Signal R. C., *Washington.*

CAMPBELL, LINDSEY F., 4th Battery, 2d P. T. R., *Fort Sheridan, Ill.*

CHASE, A. M., major, Ordnance Department, U. S. A., *Washington.*

CLARK, EDWARD L., first lieutenant, Signal R. C., McCook Field, *Dayton, Ohio.*

CLARK, ELMER J., captain, Signal R. C., *Buffalo, N. Y.*

CLARK, VIRGINIUS E., lieutenant colonel, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio.*

COE, EDW. M., first lieutenant, Quartermaster Corps, U. S. A., *Washington,* (mail) Mechanical Repair Shops No. 302, A. E. F., *France.*

COFFMAN, DON M., first lieutenant, Aviation Section, Signal R. C., Commercial Bldg., *Dayton, Ohio.*

COCKRILL, EMMET, first lieutenant, U. S. A., *Detroit,* Ordnance Department, Production Division, Carriage Sect.

DAHLQUIST, CHAS. S., major, Quartermaster Department, U. S. N. A., *Washington,* assigned to Inspection Division as supervisor of inspection on standardized military trucks.

DAYTON, WILLIAM E., private, 306th Regiment, Field Artillery, U. S. N. A., *Washington.*

DEEDS, EDWARD A., colonel, Equipment Division, Signal Corps, U. S. A., State, War and Navy Bldg., *Washington.*

DENISON, ARTHUR H., cadet, School of Military Aeronautics, Massachusetts Institute of Technology, *Cambridge, Mass.*

DE LORENZI, ERNEST A., officer, Mechanical Transport, War Department, *London, Eng.*

DE WITT, GEORGE W., ensign, U. S. N., *France,* (mail) U. S. S. Utowana, Postmaster, *New York.*

DIAMOND, JAMES E., captain, Ordnance R. C., assigned to Motor Instruction School, *Kenosha, Wis.*

DICKEY, HERBERT L., captain, Motor Equipment Section, Carriage Division, Ordnance R. C., *Washington.*

DIMOND, G. A., first lieutenant, Motor Section, Ordnance R. C., Ft. Herring, *Peoria, Ill.*

DONALDSON, FRANK A., captain, Carriage Division, Ordnance R. C., Sixth and B Sts., *Washington.*

DOST, CHARLES O., first lieutenant, Aviation Section, Signal Corps, U. S. A., Cornell University, *Ithaca, N. Y.*

DU BOSE, GEO. W. P., major, American Ordnance Base Depot, A. E. F., *France.*

DUNCAN, A. C., first lieutenant, Balloon Co. No. 7, Signal Corps, Aviation Section, Signal R. C., (mail) A. E. F., *France.*

DUNTLEY, LLOYD B., first lieutenant, Ordnance R. C., *Washington,* assigned to Engineering Motor Equipment Section.

EARLE, LAWRENCE H., captain, Ordnance R. C., assigned as inspector of ordnance, Holt Mfg. Co., *Peoria, Ill.*

EELLS, PAUL W., lieutenant, 330th Field Artillery, Artillery R. C., Camp Custer, *Battle Creek, Mich.*

ENGESSER, BENJ. M., School of Military Aeronautics, Massachusetts Institute of Technology, *Cambridge, Mass.*

ENGLISH, G. H., JR., first lieutenant, Ordnance R. C., *Washington.*

FARRELL, MATTHEW, captain, Quartermaster R. C., *Washington.*

FINKENSTAEDT, EDWARD R., captain, Military Truck Production Section, Office of Quartermaster General, *Washington.*

FISHLEIGH, W. T., major, Sanitary Corps, U. S. N. A., *Washington,* assigned as automobile engineer.

FITZGERALD, GERALD, second lieutenant, Motor Truck Co. 348, Camp McArthur, *Texas.*

FLANIGAN, E. B., Officers' Reserve Training Camp, *Plattsburg, N. Y.*

FLIEDNER, CARLYLE, captain, Motor Section, Ordnance R. C., Rock Island Arsenal, *Rock Island, Ill.*

FORRER, J. D., captain, Engineer R. C., *Washington.*

FOSS, CLARENCE M., captain, Ordnance R. C., Rock Island Arsenal, *Rock Island, Ill.,* assigned to Motor Section.

FOSTER, WILLIAM J., second lieutenant, Signal R. C., U. S. A., *Washington,* assigned to Engine Design Section, Airplane Engineering Department, Aviation Section.

FOX, RUDOLPH H., first lieutenant, Ordnance R. C., *Washington.*

FRANKLIN, G. KING, captain, Motor Section, Ordnance R. C., *Washington.*

FURLOW, JAMES W., lieutenant colonel, Quartermaster Corps, U. S. A., *Washington,* assigned to Office of Quartermaster General.

GAEBELEIN, ARNO W., lieutenant, Ordnance R. C., *Washington,* assigned to Carriage Division.

GARDNER, LESTER D., captain, 117th Aero Squadron, Signal Corps, U. S. A., *Washington.*

GETSCHMAN, G. F., second lieutenant, Ordnance R. C., *Washington.*

GEY, WILLIAM, 377th Truck Train, U. S. N. A., Camp Merritt, *Tenafly, N. J.*

GFRORER, A. H., first lieutenant, Ordnance R. C., assigned as production officer, Maxwell Motor Co., Chalmers Motor Car Co., *Detroit.*

GILLIS, HARRY A., major, Ordnance R. C., *Washington.*

GLOVER, F. S., major, Ordnance R. C., *Washington.*

GORRELL, EDGAR S., lieutenant colonel, Aviation Section, Signal Corps, U. S. A., Washington, (mail) Frank E. Gorrell, National Canners' Asso., 17th and H sts., *Washington.*

GRAHAM, LOUIS, lieutenant, 309th Engineers, Engineers R. C., *Camp Zachary Taylor, Ky.*

GRAY, B. D., major, Equipment Division, Aviation Section, Signal R. C., Lindsey Bldg., *Dayton, Ohio.*

GRAY, SAMUEL W., first lieutenant, Signal Corps, U. S. A., A. E. F., *France,* assigned to 4th Co., 2d Motor Mechanics Regiment, Ground Division, Aviation Section.

GREEN, GEO. A., captain, Tank Section, British E. F., *France.*

GUTHRIE, JAMES, major, Ordnance R. C., *Washington,* assigned to Field Artillery Section, Carriage Division.

HAESKE, F. C., lieutenant, U. S. A., Camp Sherman, *Chillicothe, Ohio.*

HALL, ELBERT J., major, Engine Design Section, Engineering Division, Signal Corps, U. S. A., *Washington.*

HALL, RICHARD H., JR., first lieutenant, Quartermaster Corps, U. S. N. A., *Washington.*

HARMS, HENRY W., captain, Aviation Section, Signal Corps, U. S. A., *Washington.*

HARTMAN, A. A., private, U. S. N. A., Camp Devens, *Ayer, Mass.*

HEGEMAN, HARRY A., major, Quartermaster Corps, U. S. A., *Washington,* assigned to office of Officer in Charge of Transportation.

HENDERSON, S. W., first lieutenant, Ordnance R. C., *Washington.*

HOBBS, J. W., first lieutenant, Ordnance R. C., U. S. A., (mail) Holt Mfg. Co., *Peoria, Ill.*

HOFFMAN, ROSCOE C., captain, Carriage Division, Motor Equipment Section, Ordnance R. C., *Washington.*

HORINE, M. C., second lieutenant, Aviation Section, Signal R. C., *Washington.*

HORNER, LEONARD S., major, Equipment Division, Signal Corps, U. S. A., *Washington.*

HOWARD, WALTER S., first lieutenant, Military Truck Production Section, office of Quartermaster General, *Washington.*

HOUSTON, HAROLD S., 3d Officers' Training Camp, *Fort Monroe, Va.*

HOYT, F. R., lieutenant, Aviation Section, Signal R. C., A. E. F., *France.*

HUBBELL, LINDLEY D., lieutenant colonel, U. S. N. A., Ordnance Department, *Springfield, Mass.,* assigned as Officer in Charge, Hill Shops, Springfield Armory.

HULL, M. LAIR, private, Ordnance Department, U. S. A., *Washington,* assigned to Trench Warfare Unit, Requirement Section, Control Bureau.

JACO, E. L., captain, Engineer R. C., U. S. A., *Washington,* assigned to General Engineering Depots.

JEFFREY, MAX L., first lieutenant, Military Truck Production Section, Office of Quartermaster General, *Washington.*

JENNINGS, J. J., first lieutenant, Quartermaster R. C., A. E. F., *France.*

JOY, HENRY B., lieutenant colonel, 4th Motor Mechanics Regiment, Signal Corps, U. S. A., *Camp Hancock, Ga.*

JUNK, FRED H., cadet, U. S. Army School of Military Aeronautics, Mass. Inst. of Tech., *Cambridge, Mass.*

KALB, LEWIS P., major, Quartermaster Corps, U. S. N. A., *Washington.*

KENDRICK, JOHN F., Signal Corps, A. E. F., *France,* assigned to Research Inspection Division.

KENNEDY, H. H., lieutenant, Ordnance Department, U. S. A., *Washington,* assigned as inspector of ordnance.

KLEMIN, ALEXANDER, sergeant, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio;* assigned to research, Airplane Engineering Department, Aviation Section.

KLINE, H. J., first lieutenant, Ordnance R. C., *Washington,* assigned to Anti-Aircraft Section, Carriage Division.

KOHR, ROBERT F., second lieutenant, Engineers R. C., *Washington.*

KOTTNAUER, EDWIN H., first lieutenant, Ordnance R. C., assigned to The Nash Motors Co., *Kenosha, Wis.*

LANE, ABBOTT A., first lieutenant, Aviation Section, Signal R. C., *Detroit, Mich.*

LANZA, MANFRED, major, Quartermaster Corps, U. S. A., 303rd Motor Supply Train, Camp Dix, *Wrightstown, N. J.*

LARSEN, LESTER REGINALD, second lieutenant, Engineer R. C., *Washington.*

LAVERY, GEO. L., JR., first lieutenant, Ordnance R. C., *Washington.*

LAY, ARTHUR J., captain, Aviation Section, Signal R. C., *Washington.*

LEFEVRE, WM. G., lieutenant, Ordnance R. C., *Washington.*

LEWIS, CHARLES B., captain, Ordnance R. C., Camp Lewis, *American Lake, Wash.*

LEWIS, HARRY R., JR., first lieutenant, Ordnance R. C., Springfield Armory, *Springfield, Mass.*

LIBBEY, E. B., lieutenant, 2nd Caisson Co., 102nd Ammunition Train, U. S. N. A., *Spartanburg, S. C.*

LIPSNER, B. B., captain, Record Section, Aviation Section, Signal R. C., *Washington.*

MCCORMICK, BRADLEY T., captain, Ordnance Department, U. S. A., *New York.*

MCINTYRE, H. C., captain, Ordnance R. C., *Washington.*

MCMURTRY, ALDEN L., captain, office of Surgeon General, Sanitary Corps, U. S. N. A., *Washington.*

MACKIE, MITCHELL, major, Quartermasters Corps, U. S. A., A. E. F., *France,* assigned to Motor Truck Transport Section.

MARMON, HOWARD, major, Airplane Engineering Division, Signal R. C., McCook Field, *Dayton, Ohio.*

MARSHALL, W. C., captain, Ordnance R. C., *Washington.*

MARTIN, KINGSLEY G., captain, Quartermaster R. C., *Camp Dodge, Iowa.*

MASON, GEO. R., lieutenant, A. E. F., *France.*

MATTHEWS, MEREDITH, private, Ordnance Motor Instruction School, U. S. A., *Camp Herring, Peoria, Ill.,* assigned as auto expert.

MAY, HENRY, JR., first lieutenant, Quartermaster C., N. A., *Washington,* assigned as inspector of Type B engines.

MAY, O. J., captain, Aviation Section, Signal R. C., Camp Custer, *Battle Creek, Mich.*

MERGI, WILLIAM, Co. B, First Battalion, 153d Depot Brigade, Camp Dix, *Wrightstown, N. J.*

MIDDLETON, RAY T., first lieutenant, Air Service, A. E. F., *Paris, France.*

MILLER, B. F., major, Quartermaster Corps, U. S. A., *Washington.*

MILLER, C. A., first lieutenant, Quartermaster Corps, U. S. N. A., *Washington.*

MILLER, DONALD G., first lieutenant, Ordnance R. C., U. S. A., (mail) Nash Motors Co., *Kenosha, Wis.*

MITCHELL, C. B., lieutenant, 4th Motor Mechanics' Regiment, *Camp Hancock, Ga.*

MOFFAT, ALEX. W., ensign, commanding U. S. S. "Tamarack" (S. P. 561), Naval Defense Reserve, Postmaster, Foreign Station, *New York.*

MONCRIEFF, V. I., captain, Aviation Section, Signal R. C., *Washington.*

MORGAN, M. B., captain, Ordnance R. C., *Washington.*

MURPHY, JOSEPH G., Sanitary Corps, U. S. N. A., *Washington.*

MYERS, J. L., first lieutenant, Ordnance R. C., *Washington.*

NAHIKIAN, S. M., lieutenant, Aviation School, Massachusetts Institute of Technology, *Cambridge, Mass.*

NORRIS, G. L., captain, Signal R. C., U. S. A., *Pittsburgh, Pa.*

OLDFIELD, LEE W., captain, Signal R. C., *Washington,* assigned as aeronautical engineer.

OMMUNDSON, H. P., Flying Corps, U. S. N., Aeronautic Station, *Pensacola, Fla.*

ORTON, EDWARD, JR., major, Quartermaster R. C., *Washington*, assigned to Motor Transport Branch, Engineering Section.

OTTO, HENRY S., lieutenant, Intelligence Section, A. E. F., *France*.

PAGE, VICTOR W., first lieutenant, Aviation Section, Signal R. C., *Mineola, N. Y.*

PAINE, C. L., captain, Ordnance R. C., *Washington*.

PARKER, RICHARD E., captain, Quartermaster R. C., *Washington*, assigned to Southern Department.

PEARMAIN, W. J., captain, Ordnance R. C., A. E. F., *France*.

PEIFER, CARL B., lieutenant, Specification Section, Signal Corps, U. S. A., *Washington*.

PETERSON, F. SOMERS, ensign, Naval Air Station, *San Diego, Cal.*

PFEIFFER, BEN. S., first lieutenant, Ordnance R. C., Rock Island Arsenal, *Rock Island, Ill.*, assigned to Motor Section.

PIERCE, HUGH M., captain, Signal R. C., Call Field, *Wichita Falls, Texas*, assigned as engineer officer, Aviation Section.

POST, EDWIN M., JR., lieutenant, U. S. Air Service, A. E. F., *France*.

POTTER, AUSTIN E., lieutenant, U. S. N. R. F., U. S. Naval Aviation Forces, *France*.

POWELL, W. B., captain, assigned as officer in charge of mechanical transport, Imperial Ministry of Munitions, *Quebec, Can.*, (mail) P. O. Box 194.

PULLEN, DANIEL D., major, 7th Regiment, Engineer Corps, U. S. A., A. E. F., *France*.

PURCELL, BERNARD A., captain, Quartermaster R. C., 307th Supply Train, Camp Gordon, Ga., assigned as Commanding Officer.

RANNEY, A. ELLIOT, major, Air Division, Signal Corps, U. S. A., *Washington*.

RAWLEY, JOS., captain, Co. A, 310 Engineers, U. S. A., Camp Custer, *Battle Creek, Mich.*

RIDDLE, E. C., cadet, Aviation Section, Gerstner Field, *Lake Charles, La.*

RITTER, E. R., first lieutenant, Ordnance R. C., U. S. A., *Washington*, assigned to Production Division, Carriage Section.

ROBINSON, H. A., ensign, N. R., U. S. N., *Keyport, N. J.*

ROSE, CHARLES B., major, chief of planes and engine inspection, Inspection Department, Signal Corps, U. S. A., *Washington*.

ROSENTHAL, WM. C., sergeant, Engineer O. T. C., *Camp Lee, Va.*

ROUNDS, EDWARD W., U. S. N. R., U. S. Naval Aviation Detachment, *Cambridge, Mass.*

RUMNEY, MASON P., captain, Production Division, Ordnance R. C., *Washington*.

RUSSELL, EUGENE F., major, Ordnance Department, U. S. A., *Washington*.

SANDT, A. R., sergeant, Ordnance Department, U. S. A., Rock Island Arsenal, *Rock Island, Ill.*, assigned to Motor Section Instruction School.

SCHOENFUSS, F. H., captain, Production Section, Ordnance R. C., *Washington*.

SCHOEPF, T. N., captain, Engineer R. C., *Washington*.

SCOTT, ALLISON F. H., captain, Signal Corps, U. S. A., Langley Field, *Hampton, Va.*, assigned to Aviation Section.

SELFRIDGE, S. W., first lieutenant, Ordnance R. C., *Washington*.

SHAFER, M. S., second lieutenant, Signal R. C., McCook Field, *Dayton, Ohio*, assigned to Airplane Eng. Div.

SLADE, ARTHUR J., captain, Aviation Section, Signal R. C., *Washington*.

SMITH, EDSON H., ensign, U. S. N. R., (mail) American & British Mfg. Co., *Bridgeport, Conn.*, assigned as assistant naval inspector of Ordnance.

SMITH, FRANK E., major, Signal Corps, U. S. A., *Washington*.

SMITH, MARK A., first lieutenant, Marine Corps, U. S. N., *Washington*.

SPRAGUE, G. A., Co. D, 310th Engineers, Camp Custer, *Battle Creek, Mich.*

STEINAU, J. M., private, Sanitary Corps, U. S. N. A., *Washington*.

STRAHLMAN, OTTO E., first lieutenant, Aviation Section, Signal R. C., (mail) Mechanics Training School, Overland Bldg., *St. Paul, Minn.*

STRAUSS, N. FRANK, lieutenant, Ordnance R. C., *Washington*.

STREICHER, GEO. A., 11th Co., Engineer O. T. C., *Camp Lee, Va.*

STREETER, ROBT. L., major, Ordnance Department, U. S. A., *Rock Island Arsenal, Ill.*, in charge of truck and tractor experimental work.

SWEET, GEO. P., first lieutenant, Signal Corps, U. S. A., *Washington*, assigned to Aviation Section.

SWINTON, D. R., first lieutenant, Quartermaster Corps, U. S. A., assigned to office of Quartermaster General.

TAYLOR, PAUL B., sergeant, Medical Corps, U. S. A., *Pontiac, Mich.*

TAYLOR, S. G., JR., first lieutenant, Signal R. C., *Washington*, assigned to Motor Equipment Section.

TEETOR, D. C., captain, Ordnance R. C., *Kenosha, Wis.*, assigned to Motor Section.

THOMPSON, H. E., first lieutenant, Motor Equipment Section, Carriage Division, Ordnance R. C., *Washington*.

THOMSON, CLARKE, lieutenant, Signal R. C., *Washington*.

TITSCH, WALTER H., captain, Quartermaster Corps, U. S. N. A., A. E. F., *France*.

TOLMAN, EDGAR BRONSON, JR., first lieutenant, 311th Engineers, U. S. A., Camp Grant, *Rockford, Ill.*

TURNER, HARRY C., captain, Engineer R. C., A. E. F., *France*.

TWACHTMAN, QUENTIN, first lieutenant, Engine Design Section, Signal R. C., *Washington*.

UNDERHILL, C. R., captain, Radio Section, Signal R. C., *Washington*.

VAIL, E. L., lieutenant, Aviation Section, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio*, assigned as officer in charge of instruments and accessories.

VERITY, CALVIN W., captain, Ordnance R. C., Frankfort Arsenal, *Philadelphia*.

VINCENT, JESSE G., lieutenant colonel, Aviation Section, Signal Corps, U. S. A., Miami Hotel, *Dayton, Ohio*.

VONACHEN, F. J., lieutenant, Ordnance Department, U. S. N. A., Rock Island Arsenal, *Rock Island, Ill.*

WALDON, SIDNEY D., colonel, Equipment Division, Signal Corps, U. S. A., *Washington*.

WALL, WILLIAM GUY, major, Ordnance Department, U. S. A., A. E. F., *France*.

WALTER, MAURICE, first lieutenant, Ordnance R. C., *Washington*.

WALTON, FRANK, acting sergeant, Quartermaster Corps, U. S. A., Quartermaster Repair Unit, (mail) *Washington, D. C.*

WETHERILL, S. P., JR., major, Quartermaster R. C., *Washington*.

WHITTENBERGER, OWEN M., first lieutenant, Ordnance R. C., *Washington*, assigned to Office of Chief of Ordnance.

WILSON, T. S., lieutenant colonel, Field Artillery, *Santa Fe, N. M.*

WODEHOUSE, B. A., sergeant, Co. A, 339th Infantry, *Camp Custer, Mich.*

WOOD, HAROLD F., lieutenant, Specification Section, Equipment Division, Signal R. C., *Washington*.

WOODS, S. H., captain, Military Truck Production Section, Office of Quartermaster General, *Washington*.

WORKMAN, LEE W., 670th Aero Squadron, Aviation Branch, *Morrison, Va.*

YONKIN, HARRY F., first lieutenant, Ordnance R. C., A. E. F., *France*.

CIVILIAN HONOR ROLL

ADAMS, PORTER H., Office of the Section Commander, First Naval District, *Rockford, Me.*

ADAMS, H. J., War Industries Board, *Washington*.

AGINS, HERMAN J., Quartermaster Engineering Department, War Department, *Washington*.

ANDERSON, E. S., mechanical engineer, Aviation Section, Signal Corps, U. S. A., Rockwell Field, N. Island, *San Diego, Cal.*

ANDERSON, H. C., aeronautical mechanical engineer, Production Engineering Department, Equipment Division, Signal Corps, U. S. A., Lindsey Building, *Dayton, Ohio*.

BARE, ERWIN L., automobile body designer, Office of Quartermaster General, *Washington*.

BARNABY, RALPH S., airplane inspector, Naval Reserve Flying Corps, *Buffalo, N. Y.*

BARNHARDT, GEO. E., aeronautical mechanical engineer, Signal Corps, U. S. A., Wilbur Wright Field, *Dayton, Ohio*.

BARTON, CHAS. E., Signal Corps, U. S. A., McCook Field, *Dayton, Ohio*, assigned to Airplane Eng. Department.

BELLING, G. C. C., assistant inspector of engineering material, U. S. Navy Department, *Buffalo, N. Y.*

BOOTH, FRED C., draftsman, Motor Transport Division, Quartermaster Department, U. S. A., *Washington*.

BOURQUIN, J. F., supervisor of chassis assembly, Military Truck Production Section, Office of Quartermaster General, *Washington*.

BRADFIELD, E. S., Engineering Department, Naval Factory, *Philadelphia*.

BURTON, W. DEAN, aeronautical mechanical engineer, Signal Corps, U. S. A., *Fort Omaha, Neb.*

CALDWELL, FRANK W., aeronautical mechanical engineer, Aviation Section, Signal Corps, *Washington*, (mail) 1449 Massachusetts Avenue, N. W.

CHAPMAN, ROBERT H., U. S. N., Spartanburg, S. C., assigned to Aeronautical Division.

CHAUVEAU, ROGER, aeronautical mechanical engineer, Aviation Section, Signal Corps, *Washington*.

CHERRY, RALPH E., Signal Corps, U. S. A., McCook Field, *Dayton, Ohio*, assigned to Airplane Engineering Department.

CLARK, ELMER J., Signal Corps, U. S. A., *Portland, Ore.*, assigned as district manager of inspection.

CLARKE, THOMAS A., Signal Corps, U. S. A., *Washington*, assigned to Aviation Section as production expert.

CLEAVER, B. J., Medical Corps, U. S. A., *Fort Oglethorpe, Ga.*

COFFIN, HOWARD E., chairman, Aircraft Board, *Washington*.

COSTELLO, JOHN V., aeronautical engineer, airplane engineering division, Signal Corps, *Dayton, Ohio*.

DEKLYN, JOHN H., technical assistant, National Advisory Committee on Aeronautics, *Washington*.

DICK, ROBERT I., motor truck expert, Ordnance Department, *Camp Dodge, Iowa*.

DIFFIN, F. G., chairman, International Aircraft Standards Board, *Washington*.

DUVAL, EUGENE C., Signal Corps, U. S. A., assigned to Airplane Engineering Department, *Dayton, Ohio*.

EDGERTON, A. H., aeronautical mechanical engineer, Inspection Section, Signal Corps, U. S. A., assigned to Equipment Division.

EDMONDSON, D. E., U. S. Signal Service at Large, *Washington*, assigned as inspector of airplanes and airplane engines, Ericsson Mfg. Co., *Buffalo*.

EISELE, WILLIAM S., draftsman, Aviation Section, Signal Corps, U. S. A., *Washington*.

ELLIOTT, E. M., U. S. Public Service Reserve, Department of Labor, 1712 I Street, *Washington*.

ERICSON, FRIEHOF G., representative of Canada, International Aircraft Standards Board, *Washington*.

FERRY, PHILLIPS B., Signal Corps, U. S. A., McCook Field, *Dayton, Ohio*.

FOWLER, HARLAN D., aeronautical engineer, Aviation Section, Signal Corps, *Washington*.

FROESCH, CHARLES, aeronautical mechanical engineer, Aviation Section, Signal Corps, *Washington*.

GILL, R. O., inspector of airplanes, Equipment Division, Signal Corps, (mail) Dayton-Wright Airplane Co., *Dayton, Ohio*.

GIRL, CHRISTIAN, director, Military Truck Production Section, Office of Quartermaster General, *Washington*.

GRIMES, C. P., Signal Corps, U. S. A., McCook Field, *Dayton, Ohio*, assigned to airplane engineering department.

GORMAN, E. J. B., U. S. Flying Corps, N. R., U. S. N., *Dayton, Ohio*, assigned to inspection of airplane engines, Dayton-Wright Aeroplane Co.

GRIFFITH, LEIGH M., technical expert, National Advisory Committee for Aeronautics, Lindsey Bldg., *Washington*.

GUERNSEY, CHAS., Quartermaster Corps, U. S. A., *Washington*, assigned to Motor Transportation Board.

HALE, W. A., aeronautical mechanical engineer, Signal Corps, U. S. A., *Dayton, Ohio*.

HALLETT, GEO. E. A., aeronautical mechanical engineer, Signal Corps, Aviation School, *San Diego, Cal.*

HARRIGAN, F. P., Signal Corps, U. S. A., McCook Field, *Dayton, Ohio*, assigned to Plane Design Section.

HECKEL, C. E., truck designer, Transport Division, Quartermaster Corps, U. S. A., *Washington*.

HICKS, HARLIE H., airplane engineering division, Signal Corps, U. S. A., *Dayton, Ohio*.

HOBBS, J. W., automobile expert, Ordnance Department, Rock Island Arsenal, *Rock Island, Ill.*

HOLDEN, F. M., airplane engineering division, Signal Corps, U. S. A., *Washington*.

HONIGMAN, JOS. K., instructor, U. S. School of Military Aeronautics, Princeton University, *Princeton, N. J.*

HORNING, H. L., chief, Automotive Products Section, War Industries Board, *Washington*.

KING, CHARLES B., aeronautical mechanical engineer, Aviation Section, Signal Corps, *Washington*.

KISHLINE, FLOYD F., laboratory assistant, Quartermaster Corps, *Washington*.

KROEGER, F. C., Quartermaster Corps, U. S. A., *Washington*, assigned as engineer on electrical equipment.

KUEMPEL, REUBEN, U. S. N., Naval Air Station, *Pensacola, Fla.*, assigned to Bureau of Steam Engineering.

LADDON, I. M., aeronautical mechanical engineer, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio*.

LANE, ABBOTT A., inspector, Aviation Section, Signal Corps, (mail) Room 52, 870 Woodward Avenue, *Detroit*.

LEOPOLD, JOS., Engineers' School, U. S. School of Military Aeronautics, Ohio State University, *Columbus, Ohio*.

LONGLETZ, WESLEY, Signal Corps, U. S. A., assigned as inspector on airplane engines at The Nordyke & Marmon Co., *Indianapolis*.

McCAIN, GEO. L., Signal Corps, U. S. A., *Dayton, Ohio*, assigned to airplane engineering department, Engine Design Section.

McMASTER, MARCENUS D., aeronautical engineer, Equipment Division, Signal Corps, *Washington*.

MENNEN, F. E., Quartermaster Corps, U. S. A., *Washington*, assigned to Transportation Division.

MILLAR, THOMAS H., JR., Quartermaster Corps, U. S. A., 205 Union Station, Washington, assigned to Motor Transportation Section.

MOORHOUSE, A., Signal Corps, U. S. A., Lindsey Bldg., *Dayton, Ohio*, aasigned as engineer in Airplane Eng. Dept.

MORGAN, G. W., supervisor of plant survey, Military Truck Production Section, Office of Quartermaster General, *Washington*.

NELSON, A. L., aeronautical mechanical engineer, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio*.

NEUMANN, JOHN W., Planning Section, Machine Division, U. S. Navy Yard, *Philadelphia*.

O'MALLEY, JOHN M., instructor, Aviation School, Signal Corps, *Washington*.

OTIS, J. HAWLEY, Ordnance Department, U. S. A., Camp Dodge, *Des Moines, Iowa*.

PARISH, W. F., Signal Corps, U. S. A., *Washington*, assigned to Specification Section, Equipment Division.

PARKER, VICTOR C., Signal Corps, U. S. A., *Washington*, assigned to Equipment Division.

PARRIS, JR., EDWARD L., senior inspector, Aviation Section, Signal Corps, (mail) Ericsson Mfg. Co., *Buffalo*.

PERRIN, J. G., assistant, Signal Corps, U. S. A., 401 Lindsey Bldg., *Dayton, Ohio*, assigned to airplane engineering division.

POLLOCK, RAY C., Signal Corps, U. S. A., *Buffalo*, assigned as airplane engine inspector.

PROCTOR, C. D., Ordnance Department, U. S. A., Rock Island Arsenal, *Rock Island, Ill.*, assigned to Motor Section, Carriage Division.

RICE, HARVEY M., inspector, Aviation Section, Signal Corps, (mail) Curtiss Aeroplane Co., *Buffalo*.

RIPPINGILLE, E. V., Aviation Section, Signal Corps, *Washington*.

ROGERS, JOHN M., aeronautical engineer, Bureau of Construction & Repair, Navy Department, *Washington*.

RUCKSTELL, G. E., Signal Corps, U. S. A., assigned as aeronautical mechanical engineer, *Detroit*.

RYMARCZICK, GUSTAV M., Signal Corps, U. S. A., (mail) Splitdorf Electrical Co., *Newark, N. J.*, assigned to Aviation Sect., as senior inspector, Signal Service at Large.

SALISBURY, EDWARD V., chief of motor transportation, American International Corp., Government Shipbuilding Yard, Hog Island, *Philadelphia*.

SCHAUM, OTTO W., Signal Corps, U. S. A., Lindsey Building, *Dayton, Ohio*, assigned as aeronautical mechanical engineer, Production Engineering Department.

SCHELL, JOHN A., aeronautical mechanical engineer, Signal Corps, U. S. A., McCook Field, *Dayton, Ohio*.

SCHUPP, ARTHUR A., aeronautical mechanical engineer, Aviation Section, Signal Corps, *Washington*.

SEABURY, W. M., Field Hospital, No. 337, Camp Custer, *Battle Creek, Mich.*

SEARLE, C. A., auto-parts inspector, U. S. A., *Washington*.

SERRELL, ERNEST, aeronautical mechanical engineer, Aviation Section, Signal Corps, *Washington*.

SHILLINGER, G. P., Ground Officers' Engineering School, Kelly Field No. 1, *San Antonio, Tex.*, assigned as instructor in ignition, starting and lighting.

SIMPSON, HOWARD W., Signal Corps, U. S. A., *Detroit*, assigned as inspector of aircraft engines, Inspection Section, *Equipment Division*.

SLOANE, JNO. E., Signal Corps, U. S. A., Washington, assigned to Equipment Division.

STALB, ARTHUR R., JR., U. S. Navy Aeronautic Station, *Pensacola, Fla.*, assigned as aeronautic draftsman, Hull Division.

STANTON, D. T., military instructor, U. S. Army School of Military Aeronautics, Cornell University, *Ithaca, N. Y.*

STOUT, WILLIAM B., technical adviser, International Aircraft Standards Board, *Washington*.

STUART, H. R., Signal Corps, U. S. A., Lindsey Building, *Dayton, Ohio*, assigned as aeronautical mechanical engineer, Production Engineering Department.

THIBAULT, F. J., aeronautical mechanical engineer, Signal Corps, U. S. A., *Washington*.

TONE, FRED I., inspector, Aviation Section, Signal Corps, *Washington*.

TRACY, PERCY WHEELER, supervisor of parts plants, Military Truck Production Section, Office of Quartermaster General, *Washington*.

UTZ, JOHN G., supervisor of inspection, Office of Military Truck Production Section, Office of Quartermaster General, *Washington*.

VAN LOON, HENRY M., 310th Engineers, Camp Custer, *Battle Creek, Mich.*

VOHRER, W. R., Quartermaster Corps, U. S. A., Signal R. C., *Washington*, assigned as draftsman.

WADE, GUSTAV, inspector, Aviation Section, Signal Corps, *Dayton, Ohio*.

WALDON, C. O., National Bureau of Standards, *Washington*, assigned as laboratory assistant, Military Reserach Gas Engines.

WALDRON, RUSSELL E., Signal Corps, U. S. A., Detroit, assigned to Equipment Division.

WALKER, KARL F., automotive engineer, Quartermaster Corps, U. S. A., *Washington*, assigned to Engineering Laboratory.

WALTER, JOHN M., mechanical draftsman, Bureau of Ordnance, Navy Department, *Washington*.

WARNER, EDWARD P., Signal Service at Large, U. S. A., *Washington*, assigned as aeronautical engineer.

WATERHOUSE, W. J., aeronautical engineer, Aviation Section, Signal Corps, (mail) Dayton-Wright Airplane Co., *Dayton, Ohio*.

WHINNE, WILBUR H., inspector, Quartermaster Corps, U. S. A., *Detroit*.

WHITE, PERCIVAL, automobile expert, Ordnance Department, U. S. A., Rock Island Arsenal, *Rock Island, Ill.*

WILLIAMS, S. T., Naval Aircraft Factory, Navy Yard, *Philadelphia, Pa.*, assigned as aeronautical mechanical engineer in Engineering Department.

WINTER, E. A., War Department, Rock Island Arsenal, *Rock Island, Ill.*

WORTHEN, C. B., inspector, Aviation Section, Signal Corps, U. S. A., *Washington*.

YOUNGER, JOHN, Quartermaster Corps, U. S. A., *Washington*, assigned to Motor Transportation Engineering Office, as supervisor of engineering.

Applications *for* Membership

A list of current applications for membership is given below. The members are urged to send any pertinent information with regard to those whose names are given which the Council should have for consideration prior to their election. It is requested that such communications from members should be sent promptly.

BIGELOW, ALLEN CARYL, research assistant, Engineering Section, Motors Division, Quartermaster Corps, U. S. A., *Washington.*

BLACK, DONALD R., chief draftsman, L. W. F. Engineering Co., *College Point, N. Y.*

BOONE, CHARLES H., chief draftsman, Clark Equipment Co., *Buchanan, Mich.*

BRINTON, BRADFORD, captain, Q. M. R. C., *Washington.*

BROWN, WILLIAM G., aeronautical engineer, Massachusetts Institute of Technology, *Cambridge, Mass.*

BURCH, ALBERT C., president, Signal Motor Truck Co., *Detroit.*

CAMPBELL, ROBERT H., purchasing agent, Comet Automobile Co., *Decatur, Ill.*

CONWAY, JAMES, chief draftsman, Smith Motor Truck Corp., *Chicago.*

DUCORRON, CHARLES A. F., senior engine inspector, U. S. Signal Corps, Detroit District, *Detroit.*

ELLISON, VICTOR ROBERT, draftsman, Hall-Scott Motor Car Co., *Berkeley, Cal.*

ENGEL, PAUL H., lieutenant, engineer, Ordnance Reserve Corp., *Washington.*

FITZGERALD, WALTER L., assistant works manager, Edward G. Budd Mfg. Co., 25th and Hunting Park Ave., *Philadelphia.*

HANCHETTE, D. N., assistant engineer, Elwell Parker Electric Co., *Cleveland.*

HARPER, CARL BROWN, graduate student, aeronautical engineering, Massachusetts Institute of Technology, *Cambridge, Mass.*

LANDON, CHARLES HOWARD, lieutenant, Signal Reserve Corps, Aviation Section, *Call Field, Wichita Falls, Texas.*

LARSEN, ANDERS L., engineering department, Curtiss Airplane Co., *Buffalo.*

LUZIUS, WILLIAM CHARLES, automobile spring engineer, The Standard Parts Co., *Cleveland.*

MCKEE, L. Z., sales manager, Oklahoma Auto Mfg. Co., *Muskogee, Okla.*

MARTIN, WILLIAM W., senior partner, Martin-Whitehill Co., *Pittsburgh.*

MICKELSON, OTTO, chief engineer, Davis Mfg. Co., *Milwaukee, Wis.*

PANDOLFO, SAMUEL C., president, Pan Motor Co., *St. Cloud, Minn.*

PARRAMORE, T. H., assistant to officer in charge, Quartermaster Corps, U. S. A., *Washington.*

PEETS, CLIFFORD S., president, general manager, Union Truck Mfg. Co., Inc., *New York.*

POWELL, WALTER E., member of gage committee, Nordyke & Marmon Co., *Indianapolis.*

RANKIN, CYRUS J., mechanical expert, Willys-Overland, Inc., *New York.*

ROBBINS, E. A., U. S. inspector, Wright-Martin Corp., *New Brunswick, N. J.*

ROHRDANTZ, RICHARD J., draftsman, Sterling Engine Co., *Buffalo.*

SCHNICKEL, NORBERT H., president, Schnickel Motor Co., *Stamford, Conn.*

SCHWEDTMAN, F. C., vice-president, The National City Bank, *New York.*

SIMPSON, E. GLENN, chief engineer, Fisher Body Co., *Highland Park, Mich.*

TATE, CHAUNCEY G., chief of experimental laboratory, Rutenber Motor Co., *Marion, Ind.*

WALDNER, GEORGE JOHN, chief engineer, Alamo Engine Co., *Hillsdale, Mich.*

WEEKS, RAY B., in charge of shell production, The Sparks-Withington Co., *Jackson, Mich.*

WHITE, GEORGE A., engineering and experimental department, The Sparks-Withington Co., *Jackson, Mich.*

WOODWORTH, PHILIP BELL, dean and professor of engineering, Lewis Institute, *Chicago.*

WRIGHT, GEO. C., in charge of machine shop instruction, Michigan Agricultural College, Engineering Department, *East Lansing, Mich.*

YOUNG, LAURENCE D., sales engineer, Universal Products Co., *Detroit.*

Applicants *Qualified*

The following list of applicants have qualified for admission to the Society between March 13 and April 10, 1918. The various grades of membership are indicated by (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate; (Aff. Rep.) Affiliate Representative; (S. E.) Student Enrollment.

BECHTLOFFT, CLAUDE B. (S. E.) student, Stevens Institute of Technology, *Hoboken, N. J.*, (mail) 106 Walnut St., Ridgewood, N. J.

CLARK, WILLIAM GIBSON (M) mechanical engineer, Wilcox-Bennett Carburetor Co., 1030 Marshall St. N. E., *Minneapolis.*

COOK, J. C. (M) engineer, Master Primer Co., 1523-31 Fort St. W., *Detroit.*

CROWELL, WM. P. (J) testing engineer, Willys-Overland Ltd., *W. Toronto, Can.*

DEAN, F. A. (M) sales engineer, Hyatt Roller Bearing Co., 1120 Michigan Ave., *Chicago.*

FACTOR, HENRY (J) draftsman, inspector; Lawrance Aero Engine Corp., 116 W. 39th St., *New York.*

FIELD, EDWD. A. (M) president, general manager, Field Motor Co., *Grand Rapids, Mich.*, (mail) R. R. No. 2, W. Leonard Road.

GALE, CHARLES E. (S. E.) student, Lewis Institute, Chicago, (mail) 2424 Elm Ave., *Evanston, Ill.*

HARPER, CHARLES S. (A) president, general manager, Charles S. Harper, Inc., 817 E. Pike St., *Seattle, Wash.*

HECOX, F. C., captain, (M) in charge of standardization of military motorcycles, Engineering Branch, Motors Division, Quartermaster Corps, U. S. A., *Washington*, (mail) Office of Quartermaster General.

HEWITT, GEORGE P. (A) sales manager, Four Wheel Drive Auto Co., *Clintonville, Wis.*

HORN, E. AUSTIN (S. E.) student, Lewis Institute, *Chicago*, (mail) 5733 W. Superior St.

HUNKER, EARL M. (A) assistant plant manager, Cleveland Axle Mfg. Co., *Canton, Ohio.*

KASTLER, E. L. (M) mechanical engineer, The Holt Mfg. Co., *Stockton, Cal.*, (mail) Y. M. C. A.

KIRKHAM, C. B. (M) chief engineer, Curtiss Engineering Corp., *Garden City, New York*; chief engineer, Motor Division, Curtiss Aeroplane & Motor Corp., *Buffalo*, (mail) 29 Euston Road, Nassau Blvd., New York.

MACCALLUM, A. A. (M) manager, The Hess-Bright Co., 419 Call Bldg., *San Francisco.*

MARQUETTE, M. A. (A) assistant general production superintendent, The Fisk Rubber Co., *Chicopee Falls, Mass.*

MILLS, STANLEY W. (M) chief engineer, Highway Tractor Co., *Indianapolis.*

MOODY, C. S. (M) assistant metallurgist, Minneapolis Steel & Machinery Co., *Minneapolis.*

PORTER, W. S. (M) manager, president, W. S. Porter & Co., 4 W. Austin Ave., *Chicago.*

RIDDELL, MATTHEW R. (M) director of testing, Canadian Aeroplanes Ltd., Dufferin St., *Toronto, Can.*, (mail) 50 Glenwood Ave.

RUCK, EDWARD H. (M) chief engineer, Cleveland Tractor Co., *Cleveland.*

SANFORD, GLENN A. (A) sales engineer, Jackson Rim Co., *Jackson, Mich.*

SAWYER, ELIAS N. (A) general superintendent, Cleveland Tractor Co., *Cleveland.*

SCHMIDT, OSCAR F. (J) student, Purdue University, *W. Lafayette, Ind.*, (mail) 78 Linden Ave.

SCOTHORN, R. J. (A) salesman, The Steel Products Co., *Cleveland.*

SHAW, EDWARD T. (M) president, chief engineer, Berkshire Magneto Co., *Pittsfield, Mass.*, (mail) 539 South St.

SHERRY, RALPH H. (M) metallurgist, General Motors Corp., *Detroit*, (mail) 121 Hazelwood Ave.

SUDEN, RICHARD (M) engineer, Kleiber & Co., Inc., 11th & Folsom Sts., *San Francisco.*

SWEET, GEO. W. (A) inspector of ordnance, Ordnance Department, U. S. A., *Washington*, (mail) Studebaker Corp., South Bend, Ill.

THOMPSON, HAROLD T. (A) factory superintendent, Abbott Corp., *Cleveland*, (mail) 401 W. 10th St., Erie, Pa.

WALTON, HAROLD E. (S. E.) student, Michigan Agricultural College, *E. Lansing, Mich.*, (mail) Electric House.

WARFEL, HOWARD ANDREW (M) assistant chief draftsman, Nordyke & Marmon Co., *Indianapolis.*

WELSH, W. E. (A) Aviation Section, Signal Corps, U. S. A., *Washington, D. C.*, (mail) 1943 Allison Ave., Des Moines, Iowa.

WILLIAMS, LOUIS B. (M) sales engineer, The Dayton Engineering Laboratories Co., *Dayton, Ohio*, (mail) 809 Grand Ave.

VENNER, A. W. (A) superintendent, The Fisk Rubber Co., *Conshohocken, Pa.*

Book Reviews *for* S. A. E. Members

This section of THE JOURNAL contains notices of the technical books considered to be of interest to members of the Society. Such books will be described as soon as possible after their receipt, the purpose being to show the general nature of their contents and to give an estimate of their value.

BROACHES AND BROACHING. By Ethan Viall. Published 1918 by the McGraw-Hill Book Company, Inc., 239 W. 39th St., New York. Cloth, 6 by 9-in., 221 pages, 187 ill., 36 tables. Price $2.

The automobile industry has been directly responsible for the development of many mechanical and machine-shop processes. The broach, which was practically unknown before the days of automobile production, exemplifies this development well, for now its application has increased to such an extent that it is used in practically every industry. All past engineering work seems to have entirely overlooked the importance of broaching, Mr. Viall's book, "Broaches and Broaching," being the first to give this valuable process the importance that it deserves.

The author states that the present work has been compiled in an endeavor to bring to the attention of engineers in all industries a working knowledge of broaching and broaching machinery as it exists at present, so that they will be enabled to judge whether this process is applicable to their particular work, and, if it is, to give them whatever working directions and information the author has been able to compile.

What machine operations constitute broaching is a much-mooted question. Many examples, such as the work of a keyseater using a multiple tooth cutter, might be cited; the average person would not venture to commit himself as to whether this work might be called broaching. The author's definition is exceptionally good, and should clear up any questions as to what constitutes broaching:

> Broaching is the working out of holes or slots, or the machining of surfaces, by tools having a number of successive cutting teeth of increasing size, no matter whether these teeth are arranged singly or in multiple.

Recent improvements in broaching machines and broaching tools have greatly cheapened the cost of production in broaching various kinds of work. One great advantage of broaching as a means of finishing certain parts over machining, or any other method, is that the action of the broach serves as a clamping medium, so that often nothing else is needed to hold the work in place. This item is of the greatest importance, as in many cases the chucking of an irregular piece takes much more time than the actual machine operation. Another advantage, which the author emphasizes, is that there is little resulting scrap. Mention is made of one automobile factory, probably the first to use broaching to any extent, which kept account of 10,000 pieces of all kinds, and found that less than 1 per cent were spoiled in the process of broaching, a record which could not be approached in any other process of machining.

The standard types of broaching machines are classified and described by the author, these being restricted to those used expressly for broaching work, and as such put upon the open market. In the case of the pull broaching machine, this classification is a simple matter, but as a large number of the machines used for push broaching are also used for other machine operations this section is necessarily incomplete.

Broaching work and practice are covered in two very complete chapters, which deal separately with pull broaching and push broaching. The large number of excellent photographs used in conjunction with the text bring out the great number of different operations very clearly.

The design of push and pull broaches are dealt with in an extremely capable way. Many tables are given, compiled from actual shop practice, to guide the designer of push broaches. These tables alone form a valuable part of the book. The manufacture of broaches is covered by giving many descriptions of actual shop practice which serve as a guide for machining, hardening, grinding and strengthening of broaches of the various types. The appendix contains recommended S. A. E. practice for the dimensions of square broach fittings, six, ten and four-spline and taper fittings for castle nuts.

STEEL AND ITS HEAT TREATMENT. Second Edition. By Denison K. Bullens. Published 1918 by John Wiley & Sons, Inc., New York. Cloth, 6 by 9-in., 483 pages, 285 ill. Price, $4.

This second edition has been amplified and broadened to include additional information of a practical nature, illustrating the applications of the principles upon which everyday commercial practice is based. The elements of each cycle of heat-treatment operations from first to last are presented.

The general scope of the work has been covered in the review of the first edition, which was published in the September JOURNAL, page 226. Much additional matter has been added to the chapters on Heat, Forging, Annealing and The Human Element.

A number of microphotographs and other illustrations have been used to supplement the large number used in the first edition. These were based on personal observation of the author, and form a valuable addition.

In the section on Heat, additional data are given to illustrate the difference between combustion and generation of heat and the application of heat to useful work; the difference between the mere indication of uniform temperature and uniformly heated product; the relation between temperature, time, mass and surface in the determination of uniformly heated product; the influence of furnace design and operation on the quality and cost of finished product; the danger of relying on pyrometer readings without considering other equally important factors; and the factors governing the selection of furnaces and fuels and the use of both.

The influence of the "Human Element," while not involved in a technical consideration of scientific principles, is nevertheless an important factor in the practical side of the work, and it is considered more in detail for the reason that there has been shown nothing so far to prove that it is not essential. It is believed that the practice of the art of heat treatment is a specialty or trade in itself, requiring skilled men for its proper conduct, and that the shop practice cannot keep pace with laboratory development until this point is recognized and sustained. To

(Concluded on page 54, advertising section)